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Nursery & Market Garden Industries' - Development Society, Limited. -

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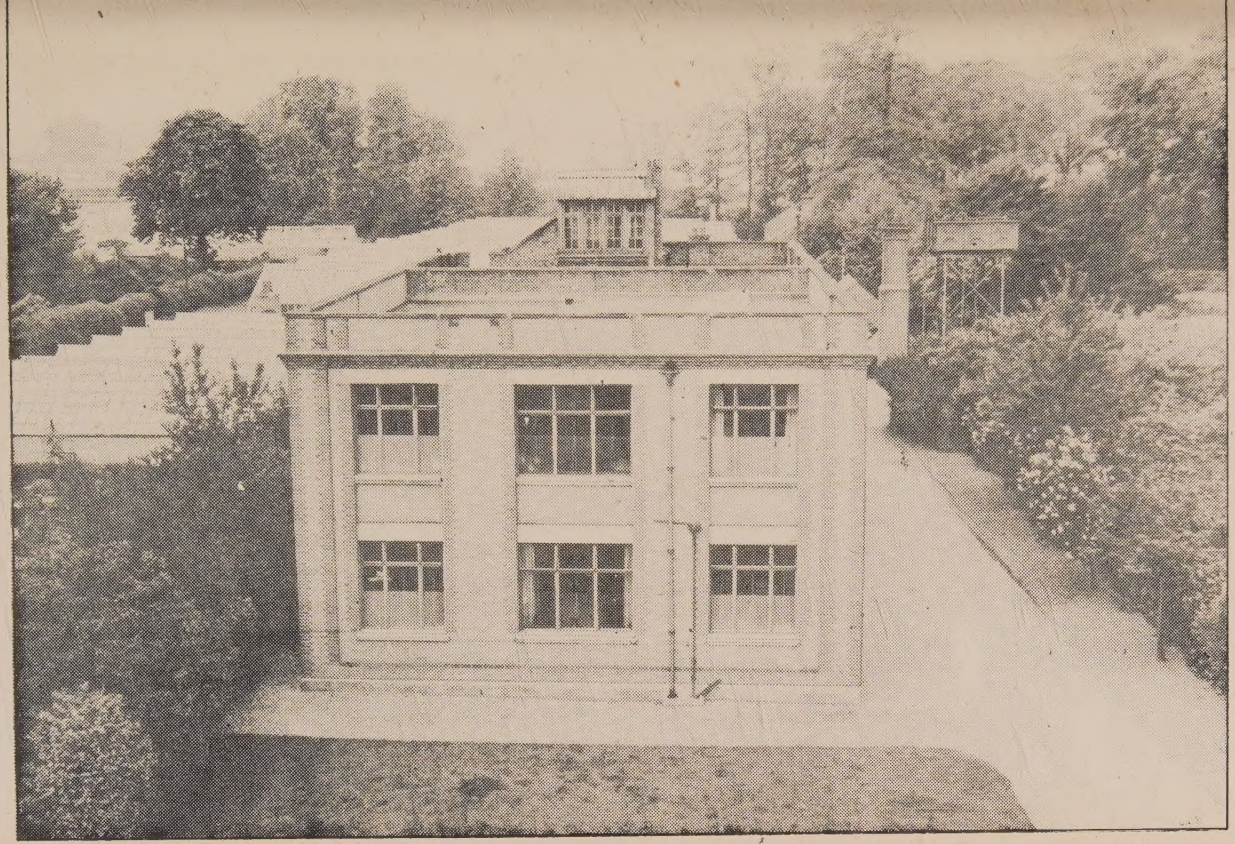

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Introduction.

THOSE in the glasshouse industry can look back on this the third year of war with a good deal of satisfaction for they produced a heavy yield of tomatoes which with the outdoor crop more than equalled the total of home grown and imported produce in the years of peace. The turn-over from flower to food crops is almost complete and from now onwards tomatoes in the summer, with lettuce and mustard and cress in the winter are the crops approved by the Government. To them all other crops must give place with a few exceptions where a small area is allowed for the purpose of retaining valuable stocks which will be needed after the war. There have been certain difficulties with regard to supplies, but they have been solved and business has proceeded as usual.

The work of the Cheshunt Research Station has continued, less attention being given to long range research and more to the multitude of urgent problems which required immediate solution.

The tomato crop generally has been a heavy one. That grown at the Station has been a record, thanks to the sterilization of the soil by steaming and the fact that April and May were both exceptionally sunny. The relation between light conditions in these two months and the total season's crop has long been suspected, and conditions this year provide confirmation, for total hours of bright sunshine recorded have been exceptional. During these months growth was exceptionally good and the plants made a solid foundation upon which to build a heavy crop.

A second National Trial of outdoor tomatoes was organised. Twenty-three counties took part, twenty in England and three in Wales. Our thanks are due to the county officers who did so much to make the trials a success.

A short course on commercial glasshouse work was organised for the five days commencing Monday, March 23rd, at the request of several counties who wished the junior members of their horticultural staffs to obtain the latest information. It was attended by thirty-four horticultural officers. Papers were read by members of the Research Station Staff, visits were made to local nurseries and periods were set apart for the discussion of glasshouse problems. The venture was highly successful and at the request of those who attended another course will be arranged during 1943.

Current Investigations.

The experiments commenced in 1940 to study the relative effects of muriate and sulphate of potash have been continued on the same plots. No harmful foliage effects have been observed during any of the three years. The mean yields for the three years were 56.09 tons per acre from the sulphate and 53.44 tons from the muriate. The difference between them is not quite significant and it is assumed that under the conditions of the experiment the difference in crop yield is negligible. Seasonal and other factors exert much greater influence on the total yield than the variation between these two sources of potash. It must be remembered, however, that harmful results may be produced when the soil of the nursery is by nature rich in chloride.

Another experiment was arranged in which the variety Potentate, noted for the heavy weight of fruit it produces on the lowest five trusses, but which tends to become weaker in the tops, was interplanted with

Watson's Best of All, a variety remarkable for the strength and cropping power of the tops. No advantage is recorded from interplanting on steam sterilised soil.

Tomatoes were grown for the third year in cucumber houses by the roof-crop method which is now adopted extensively for small houses. An average yield of 47.9 tons per acre was recorded. The effect of light observed during the two previous years was recorded once more, for the yield from each of the four houses increased from 45 tons per acre to 53.5 tons per acre as the shade from the laboratory buildings became less.

Variety trials were continued as in past years. In house 1 the heaviest yields were obtained from E.S.1., Rodbastin No. 1 and the F1 generation of a Bides Recruit-Radio cross. In house 2 the F1 generations of two crosses produced outstanding yields. From Stirling Castle X E.S.1 the crop was 73.4 tons and from Stirling Castle X Up-to-Date it was 69.9 tons per acre. Vetomold, 42.0 tons per acre, again proved resistant to *Cladosporium fulvum*. This variety is being tried extensively all over the country and some very good reports have been received from some nurseries, especially where the soil is rich and open and where warm, moist conditions can be provided.

Cheshunt Early Giant lettuce in glasshouses and Cheshunt Early Ball in frames have both maintained their excellence. Many splendid crops have been grown in different parts of the country. The new 5a hybrid between Cheshunt Early Giant and Green Frame has proved more suitable than the former both for steam sterilised soil and for very rich soil. It matures 10-14 days earlier than Cheshunt Early Giant and growers are advised to give it a trial.

The investigation of *Verticillium* wilt of the tomato has been continued, and a method for estimating the resistance of seedlings to this fungus, devised originally

in America in connection with *Fusarium* wilt of the tomato, has been tested. Tomato seedlings were readily infected by this method which consists of dipping the roots in a liquid culture of the fungus before potting. Of the criteria which might be used for estimating resistance such as the extent of browning in the stem, the height to which the fungus penetrates upwards in the plant, and the number of yellow and dead leaves, only the latter appears to give reliable results capable of being easily and quickly recorded. The resistance of certain tomato varieties was found to vary according to the method of cultivation.

In this respect the resistant varieties Manx Marvel (English) and Riverside (Californian) were significantly more resistant than Ailsa Craig when inoculated with an old white culture of *Verticillium albo-atrum* but shewed no resistance to a younger culture which produces pseudo-sclerotia abundantly. Ailsa Craig reacted in the same way to both these strains.

Several cases of infection of the immune variety Vetomold by *Cladosporium fulvum* have been reported during the year. Inoculation experiments carried out towards the end of the season suggest that these attacks may be due to a distinct strain of the fungus. Strains capable of infecting Vetomold have already been reported from Canada where the variety was raised.

Didymella lycopersici caused widespread damage to tomato plants in 1942, attacking plants both in glasshouses and in the open. Experiments have shewn that the plants can be attacked at all stages of their development and that the occurrence and spread of the disease is closely connected with cultural conditions and practices.

Experiments were arranged to determine the cause of a fruit blemish which occurs on Stonor's varieties of tomatoes when grown out-of-doors. Inoculation with spores of *Botrytis* under varying conditions gave negative results as also dip the application of a number

of sprays used against Blight (*Phytophthora infestans*). It is concluded that the blemish is not due to attack by an organism but is produced under certain weather conditions which are as yet unknown.

From observations upon the movements of wireworms towards carrot baits buried in the soil of a glasshouse it is concluded that trapping by such a method would have to be extended over a long period if the wireworm population is to be reduced materially. During the early part of the year wireworms feed more or less regularly over a period of some three weeks, after which feeding either becomes irregular or ceases altogether for a time. In a glasshouse planted with lettuce wireworms introduced into the soil tended to remain in the vicinity of plants they had destroyed, and attacked replacements of these rather than established plants nearby : the loss of plants planted upon raised ridges was much greater than of those planted on level ground.

Sprays containing tarter-emetic and glycerin, advocated in U.S.A. for the control of Red Spider-mite on cucumbers and carnations caused severe injury to the foliage of tomato plants largely due to their glycerin content. Solutions of tartar-emetic with various wetting agents gave variable results, and injury to foliage was caused by sprays containing sufficient tartar-emetic to give a high mortality of the mite. Under experimental conditions the application of potassium iodide solution to soil infected with Root-knot Eelworm did not prevent the formation of nodules upon the roots of tomato plants.

The leaf-miner has become very prevalent in the Lea Valley. The insect starts breeding upon seedlings in the propagating houses destroying a proportion of them.

Applications of dusts containing nicotine and atomised sprays are preferable to ordinary sprays in such cases.

Investigation of the efficiency of a number of tar acid fractions as soil sterilising agents has been commenced. These tar-acid fractions were kindly supplied by the Chemical Research Laboratory of the Department of Scientific and Industrial Research and the investigations are part of a larger scheme planned to determine the value of various products derived from coal tar as soil sterilising agents, insecticides and fungicides for use in the glasshouse industry. For this purpose it has been necessary to develop methods suitable for the preliminary laboratory examination of chemical agents as soil sterilisers.

The comprehensive field trials of fungicidal sprays and dusts for the control of Blight (*Phytophthora infestans*) on outdoor tomatoes proved disappointing owing to the complete absence of this disease on all the plots. The trials have yielded some useful information however, regarding the effect of a number of these treatments on the plants and fruit.

The occurrence of a serious attack of tomato stem rot (*Didymella lycopersici*) on tomatoes grown under glass, and the realisation that this disease is one of the most important causes of fruit rot of outdoor tomatoes in this country, has necessitated investigations on its prevention and control. The work has included experiments in the use of protective fungicides applied to the plants as sprays or dusts, soil treatment and also protection of the " collar " of the plants at which point infection normally occurs on glasshouse tomatoes.

There has been a marked decrease in the number of insecticidal and fungicidal products examined, but on the other hand the number of samples of formaldehyde sent for analysis has increased very considerably.

A number of nutrition experiments have been carried out in connection with the " minor " elements. It has been claimed recently that lettuce plants develop

a better colour when receiving molybdenum in the nutrient, but in one experiment where lettuce plants were grown both in pots and in borders, the addition of molybdenum made no observable difference to the appearance of the plants. Presumably the soil and composts used here contain adequate molybdenum or alternatively other nutrients present are able to mask the symptoms of molybdenum deficiency.

With tomatoes in sand cultures, the omission of boron, magnesium or manganese produces very definite effects. Boron deficiency caused a decided stunting, leaves and stems became exceedingly brittle and were easily snapped off when touched. In addition a characteristic leaf scorch occurred, but it is possible to confuse this effect with that sometimes associated with acute potassium deficiency. Omission of magnesium also caused stunting and leaf scorch of a different kind. In this case the tips of the leaflets lost their turgidity and eventually withered in a characteristic manner. Manganese deficiency on the other hand produced hardly any appreciable stunting: in fact for some weeks no effects were discernable. Eventually a characteristic mottle occurred in which apparently uniform yellow specks shewed up against the greyish green background of the leaflets. It is probable that the plant's requirements of all three elements are low, but their absence produced very definite effects.

Obituary.

It is with sincere regret that we record the death on August 24th, 1942 of our President, Mr. C. H. Shoults, in his 77th year. He took a very active part in the creation of the Research Station and served as its treasurer from 1913 to 1934, when, on the death of the late Mr. H. O. Larsen, he was elected President.

He was one of the " Three Musketeers," with the late Mr. H. O. Larsen and Mr. Jacob Nielson, happily still with us, who were chiefly responsible for the development of the Station ; with them he guaranteed, from time to time, large sums of money so that our extension projects could be put in hand. Any scheme which seemed likely to benefit the industry had his immediate sympathy, and he gave whole-hearted support to every side of the Station's work. Very active also was he in the formation of the Market Growers' Seed Association, Ltd., the object of which is to grow and sell virus-free seeds. Mr. Shoults realised at once the importance of such a project to the industry. He was chairman of the company since its inception in 1939.

Our debt of gratitude to him is increased by the freedom with which he imparted his vast store of practical knowledge. He was always willing to help the Station by means of experiments on his own nurseries, and his critical observations were most valuable in assessing the commercial value of any new treatment.

In all this we honour him, but it was the character of the man that earned our affection. He was always so quietly unassuming, so unwilling to place himself in the limelight, so generous in his praise, so helpful when things were going wrong, so wise in his advice, and withal so genial and boyishly humorous when circumstances permitted.

DIRECTOR'S REPORT.

Experimental Results of 1942.

1. Tomatoes.

The practice of grading the tomato fruits from the experimental plots, adopted in 1921, was continued :—

A.—" Pinks " number 5 to 7 and " Pink and White " 8 to 10 to the lb. These are the best quality of fruit in size, shape and colour ; " Pinks " being slightly larger than " Pink and Whites."

B.—" Whites." These fruits are of good colour but smaller than " Pink and White."

C.—" Blues." This grade consists of fruits of good colour but larger and more irregular in shape than Grade A.

D.—" Roughs." Small mis-shapen fruits about the size of cherries.

E.—Blotchy fruits which ripen irregularly.

F.—Fruits shewing Blossom End Rot.

G.—Fruits shewing the lesions of Streak Disease.

H.—Fruits shewing " Green Back."

(a) Houses 7—9. Sulphate of potash versus muriate of potash.

In 1940 an experiment was commenced to test the relative effects of sulphate of potash and muriate of potash on the tomato plant. Houses 7, 8 and 9 were each divided into four equal plots. Two of these received the normal manurial treatment, and in the others sulphate of potash was replaced by the equivalent amount of muriate of potash. The normal treatment is as follows :—

1.—Applied before planting.

Hoof and horn	10 cwts.	per acre.
Bone meal	10 „	
Sulphate of potash	10 „	

2.—Top-dressing.

(*a*) Sulphate of potash 5 cwts. per acre.

(*b*) A top dressing mixture containing 10% potash as sulphate of potash totalling 30 cwts. per acre.

Table 1.

Sulphate of potash versus muriate of potash. 3rd year.

House.	Plot.	Treatment.	Crop yield in lbs. per plant.							Total tons per acre.	Average tons per acre.		Percentage blotchy fruit.
			June	July	Aug.	Sept.	Oct.	Nov.	Total				
7	1	Sulphate of potash	1.39	4.05	2.65	0.90	0.66	0.36	10.01	76.07			4.21
	3	,, ,,	1.33	3.81	2.79	0.88	0.57	0.27	9.65	73.35			4.77
8	2	,, ,,	1.43	4.13	2.86	1.10	0.49	0.57	10.58	80.40	76.36	72.9	5.10
	4	,, ,,	0.96	4.36	2.49	1.08	0.47	0.59	9.45	75.62			6.74
9	1	,, ,,	0.71	3.90	2.00	0.85	0.73	0.28	8.47	64.38	65.98		1.18
	3	,, ,,	0.29	4.19	1.96	1.17	0.74	0.41	8.76	66.58			0.57
7	2	Muriate of potash	1.30	3.50	2.73	0.97	0.62	0.35	9.47	71.98			2.96
	4	,, ,,	1.21	3.83	2.24	0.84	0.44	0.31	8.87	67.42			7.10
8	1	,, ,,	1.37	4.17	2.47	1.01	0.47	0.54	10.03	76.24	72.57	70.0	5.77
	3	,, ,,	0.64	4.33	2.42	1.23	0.51	0.69	9.82	74.63			4.48
9	2	,, ,,	0.47	3.95	2.05	1.16	0.59	0.40	8.62	65.51	64.87		0.57
	4	,, ,,	0.60	3.89	1.87	1.00	0.80	0.29	8.45	64.22			0.47

Varieties. Potentate Houses 7 and 8. E.S.I. House 9.

This experiment will be continued, each year, until the end of the war, or until definite injury results from the application of the muriate.

The results of the 1942 experiment are given in Table 1.

The mean yields from the three years experiments are 56.07 tons per acre from the sulphate, with 53.44 tons per acre from the muriate, the standard error of the mean value being ± 0.95 tons per acre. On this basis, a difference of 2.85 tons per acre (three times the Standard Error) would be significant. Thus the difference in crop from the sulphate and the muriate is not quite significant, and it may be assumed for all practical purposes that so far as the Station soil is concerned the difference in effect is negligible, seasonal and other factors exerting much greater effects on the total yield of these variations than the source of supply of potash.

Two varieties E.S.1. and Potentate were grown and considering these separately there is a clear indication that Potentate differs from E.S.1. in its response.

With Potentate sulphate of potash produced 3.8 tons per acre more than the muriate, whereas there was no indication of any difference in yield with E.S.1.

(b) Houses 4 and 5. An interplanting experiment.

When the variety Potentate is grown in old nurseries on worn out soils, the growth above the fifth truss is often weak and the top crop poor. Watsons Best of All, a Scottish variety, is outstanding in the strength of its top growth and the weight produced towards the end of the season. This experiment was planned to see if a heavier crop could be obtained by planting these two varieties alternately along the rows, than when either of them was grown alone. Particulars of planting and the crop yield per acre are given in Table 3 and it will be seen that under the conditions prevailing at the time the yield was not increased by interplanting. The experiment, as it happened, was not a fair test of the system, not only because the soil was steam sterilized but because the weather was particularly favourable to Potentate. It will be repeated later, when the effect of sterilisation has weakened sufficiently.

(c) Houses 1, 2 and 3. Variety Trials.

The trials in house 1 were concerned with commercial varieties submitted by growers. The results are given in table 3. In house 2 the varieties were Leaf Mould resisters and a number of crosses with ordinary commercial varieties. Two of these shewed abnormal hybrid vigour, namely Stirling Castle x E.S.1. (73.4 tons per acre) and Stirling Castle x Up-to-date (69.9 tons per acre).

Vetomold was free from infection by *Cladosporium fulvum*, but the sister varieties G-17-16 and 40-R-1 were slightly infected.

Table 2.

Interplanting experiment.

House	Plot	Treatment.	Crop yield in tons per acre.					Percentage Blotchy ripening.
			June	July	Aug.	Sept.	Total	
4	5	Potentate, ordinary spacing	4.83	20.18	14.28	7.79	47.08	4.20
5	1	„ „ „ „ „	11.56	22.51	10.88	6.40	51.35	6.61
4	6	Potentate and Watsons Best of All planted alternately. Ordinary spacing	3.42	20.94	15.73	7.89	47.98	2.77
5	2	„ „ „ „ „ „ „ „	7.03	22.66	12.83	7.88	50.40	3.09
4	7	Potentate 18" apart in the rows, interplanted with Watsons Best of All. Potentate stopped at 5th truss and then removed to leave Watsons Best of All for top crop	3.24	21.14	12.40	6.55	43.33	4.22
5	3	„ „ „ „ „ „ „ „	4.67	23.53	10.02	5.62	43.84	3.45
4	8	Potentate interplanted with Watsons Best of All at normal spacing, but two plants of Potentate planted side by side instead of the customary one plant ...	6.35	17.96	14.32	7.17	45.80	4.21
5	4	„ „ „ „ „ „ „ „	8.29	24.34	8.39	4.34	45.36	5.07

40-R-1 proved the better of the two both in relation to quality of the fruit and resistance to the disease.

The results are given in table 3.

Table 3.
Variety Trials.

House No. 1.

Variety.	Crop weight in tons per acre.	Percentage blotchy fruit.
E.S.1.	51.45	0.45
Rodbaston No.1	50.16	2.43
Bides Recruit x Radio ...	49.55	0.92
Potentate (Slotema)	47.96	6.01
Comet	47.50	0.63
Daffern's Seedling	47.42	0.63
Comet	46.97	0.15
Cavendish Perfection ...	46.97	0.15
Cheltonia	44.50	0.63
E.S.4.	44.46	2.23
Wileman's Seedling	42.63	0.70
Welshman	41.49	0.55
Ailsa Craig, A.	41.27	0.55
Scarlet Emperor A.	40.74	1.86
Scarlet Knight B.	40.20	2.64
Cooper's Ideal	40.13	1.69

House No. 2.

Stirling Castle x E.S.1. F1	73.41	1.96
Stirling Castle x Up-to-date F1	69.92	2.60
Vetomold x Potentate ...	45.82	0.50
Paul's S 14	45.37	1.50
Vetomold x Stirling Castle F1	44.84	0.18
G. 17.16	43.63	0.60
Vetomold x Radio F1 ...	42.71	0.70
Stirling Castle x Potentate F1	42.22	4.05
Up-to-date x Vetomold F1 ...	42.64	3.65
40-R-1	42.10	0.35
Vetomold	42.03	0.35
Up-to-date x Scarlet Knight F1	41.64	3.65
Stirling Castle x Scarlet Knight F1	41.04	0.56
Up-to-date x Hillside Comet F1	40.13	1.52

(d) Tomatoes in Cucumber houses.

Tomatoes were grown in cucumber houses for the third year. The results are given in table 4, where it will be seen that the crop increases steadily from house D to house G as the shade from the laboratory decreases. All plots received standard manurial treatment and in addition the effect of mixing certain fertilisers with the second spit was examined in relation to the amount of blotchy ripening shewn by the fruit. The result was disappointing for the various treatments were without effect.

Table 4.
Tomatoes in Cucumber houses.

Plot	Treatment.	Crop yield in tons per acre.								Percentage blotchy ripening.
		June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Total	
D 1	Potash in second spit	5.46	14.88	10.98	4.86	4.02	2.67	0.30	43.17	3.5
D 2*	,, ,, ,,	5.79	16.98	12.51	5.10	4.26	2.01	0.30	46.95	4.0
E 1	Phosphate in second spit ...	5.01	14.28	11.46	5.37	4.80	2.25	0.15	43.32	3.1
E 2*	,, ,, ,,	6.03	18.00	11.82	4.80	4.56	2.37	0.15	47.73	3.5
F 1	Potash + phosphate in second spit	6.36	15.63	12.87	5.82	5.76	0.99	0.18	47.61	3.8
F 2*	Potash + phosphate in second spit	6.27	16.80	12.54	5.76	4.83	0.78	0.09	47.07	2.8
T 1	Complete artificials in second spit	9.75	19.86	9.54	4.89	6.00	2.34	—	52.38	4.0
G 2*	Complete artificials in second spit	10.50	20.10	11.79	5.28	7.26	—	—	54.93	3.6

* Potassium permanganate 2 ounces per square yard. Average 47.90 tons per acre.

The plants were grown on the roof crop system, which has been adopted by many nurserymen with satisfactory results.

(e) National Trials of Outdoor Tomatoes.

The second of the series of National Trials was organised with the co-operation of County Staffs at 21 centres in England and two in Wales. Some counties found it impossible to take part in the present trials owing to labour difficulties.

The trials were designed as follows :—

1. Single row versus double row planting.
2. Spraying to control Blight.
3. Varieties.
4. Age of plant at planting time.

1. Single row versus double row planting.

This trial consisted of a latin square arrangement of 16 plots, each 30 feet long and 15 feet wide. In the single row plots, the plants 100 per plot were placed 18 inches apart in the rows, and the rows were 3 feet apart. In the double row plots, there were 140 plants. The plants were set out 18 inches apart in the rows. The double rows were placed 18 inches apart, and paths 3 feet wide were left between.

It was possible to examine statistically the results from seven counties as given in table 5, where it will be seen that in six cases the total yield per acre was increased significantly by planting in double rows. Dr. I. W. Selman very kindly undertook the necessary calculations.

Table 5.

County	Mean of treatment yields in lbs. per plot		Difference.	Value of significant differences	S.E.%
	Single Rows.	Double Rows.			
Cheshire	262.1	319.0	**56.9**	41.5	4.72
Derby	105.3	144.5	**39.2**	45.0	11.90
Dorset	135.0	190.1	**55.1**	26.9	5.46
Northants	367.6	438.9	**71.3**	36.7	3.00
Somerset	497.3	596.9	**99.6**	42.2	2.55
W. Sussex	165.6	207.6	**42.0**	23.6	4.16
Worcester	296.4	349.8	**53.4**	29.5	2.41

Significant differences are shewn in bold figures.

The average yield per acre from the double row system of planting was as follows :—

Surrey	30.4 tons per acre.
Somerset	28.7 ,, ,, ,,
Cambridgeshire	21.8 ,, ,, ,,
Northamptonshire	19.0 ,, ,, ,,
Worcestershire	15.1 ,, ,, ,,
Cheshire	9.2 ,, ,, ,,
Staffordshire	9.6 ,, ,, ,,
Dorsetshire	8.2 ,, ,, ,,
Middlesex	31.6 ,, ,, ,,
Derbyshire	6.2 ,, ,, ,,

2. Spraying to Control Blight.

Unfortunately for this experiment the crops were singularly free from infection by *Phytophthora infestans* and therefore these trials have not increased our knowledge of Blight Control.

Mr. Steers' results from Cheshire are given below :—

Spray treatment	% infected fruit at time of picking.
Control	5.0
Spray A	2.9
Spray B	1.5
Copper dust ...	1.0
Bordeaux Mixture	1.0
Spray C	0.6

From Dorset Mr. Ferris reported that all sprays were effective, unsprayed crops in the neighbourhood being infected, while those in the trials remained clean.

From Somerset Mr. A. D. Turner emphasises the necessity of spraying in that County.

3. Varieties.

In these trials the choice of varieties was left to the County Officers, and those chosen by them as being most suitable for the county concerned are listed below :—

Variety Trials.

Centres.	*Best Varieties of 1942 trials.
Cardiff	Essex Wonder, Market King, Radio, Victory.
Cheshunt ...	Ailsa Craig, Market King, Radio, E.S.1.
Cornwall ...	M.P., Earliest of All, Market King, E.S.1, Plumpton King.
Derby ...	Potentate, Plumpton King.
Dorset	Market King, Harbinger, E.S.1.
Kent	Ailsa Craig, Market King, Hundredfold, Early Market, X-Ray.
Lincolnshire (Kirton) ...	Market King, Potentate, M.P.
Middlesex ...	E.S.1, Plumpton King, Exhibition, Moneymaker, Market King.
Montgomery ...	Potentate, Radio, Market King, E.S.1.
Norfolk	Essex Wonder
Northamptonshire	Hundredfold, Radio, Market King.
Somerset ...	Essex Wonder, Market King, Money Maker, Histon Ideal.
Staffordshire ...	Radio, Potentate, Exhibition, Gradewell, Prolific.
Surrey	Exhibition, Harbinger, Hundredfold.
Sussex (East) ...	Plumpton King, Gradewell, Woolman's Wonderful

*Based on weight of fruit marketed.

4. Age of plant at planting time.

Few counties attempted this experiment. In Middlesex plants planted from size 60 pots or boxes (6 plants per box) gave a higher yield (5 lbs. per plant) than those from size 48 pots (3.8 lbs. per plant). In West Sussex, those planted from 48's gave the heaviest crop, while plants planted from boxes gave a heavier yield than those from size 60 pots.

In Somerset Mr. Turner advises planting when the first truss is starting to shew some colour, but he is careful to insist that the plants must not be too hard and woody at planting time.

2. Other Crops

(a) Lettuce.

Cheshunt Early Giant lettuce is doing splendid work in the winter food effort. Now that growers have learned how to get the best out of it, large acreages are grown each year for marketing between December and March. Cheshunt Early Ball is becoming increasingly popular as a frame lettuce and many good crops are recorded also from cold houses.

Two new varieties *5a* and *5b* which are very similar in habit have been obtained by crossing Cheshunt Early Giant and Green Frame. They mature somewhat earlier than Cheshunt Early Giant and are more suitable both for steamed soil and very rich open soils. Seeds of all the above varieties can be obtained from the Research Station.

(b) Carrot.

A small quantity of Scarlet frame carrot seed is also available through the courtesy of Messrs. Ferry Morse Seed Co. of California. This carrot has been tested in the experimental houses and found suitable for glasshouse work in this country. Unlike all other varieties which have been tested it produces a very small top. The root itself is bright red in colour and of high quality. In our tests it was grown between the rows of tomatoes, the seeds being drilled about the middle of January, leaving room to plant the tomatoes later.

2. Plant Diseases.

1. Verticillium Wilt of the Tomato.

P. H. WILLIAMS.

During the past year the *Verticillium* investigations were concerned with (*a*) the elaboration of methods for estimating the resistance of various tomato varieties and (*b*) the reaction of Manx Marvel and Riverside (American) to infection by the fungus.

(a) Methods for estimating resistance.

During recent years a method for determining the resistance of tomato seedlings to *Fusarium bulbeginum* var. *lycopersici*, the cause of *Fusarium* wilt, has been developed in America. It consists of dipping the roots of seedlings in a liquid culture of the fungus and then planting them in large trays on the greenhouse bench. The workers claim that by observing the extent of browning in the stem, the number of wilted leaves etc., it is possible to estimate the resistance of the plants and further that the results so obtained are confirmed by field experiments. If this is true also for *Verticillium* wilt the method would save a great deal of time in the selection of resistant varieties for further trial. Experiments in 1941 shewed that tomato seedlings could be infected with *Verticillium* very easily by dipping the roots in a liquid culture and so in 1942 a series of experiments were designed to work out further details.

The general procedure was to sow tomato seeds in steamed soil. When the seedlings shewed two rough leaves they were removed from the box and as much of the loose soil as possible was shaken from their roots. The roots were then dipped in a liquid culture of *Verticillium* and the plants potted up in sterilised soil. The liquid cultures were prepared by growing the fungus on Czapek's solution for ten to fourteen days, the cultures being shaken at intervals to prevent the formation of a thick mat of mycelium on the surface.

Several strains of *Verticillium* were used but only two shewed a high degree of virulence, an old type culture of *V. albo-atrum* obtained from Baarn some years ago and V243, a strain isolated from tomatoes from Guernsey in 1939 and used in the 1941 experiments. In every experiment sixteen plants of each variety were inoculated with each fungus and these plants were arranged in groups of four in four randomised blocks so that the results might be analysed statistically.

The plants were examined four weeks after potting. They were cut off at soil level, the total number of leaves and the number of dead and yellow leaves being counted. Isolations were then made

at 3 cm intervals up the stem starting at the cotyledons. Pieces of tissue were removed aseptically and placed on slopes of Czapek's agar. At the same time the height to which browning of the wood extended was noted.

The results of three experiments indicated that serial isolations occupied too much time, five to six days being required to examine ninety-six plants. This time was, of course, increased by interruptions due to advisory work which it was impossible to avoid. The length of time taken to examine the plants renders the results less reliable since the fungus might be able to make considerable progress in the interval or on the other hand its progress might be slowed up in susceptible varieties by unfavourable temperature conditions.

Another complication is that the fungus often advances further up one side of the stem than another. Isolations made by removing pieces of tissue aseptically may therefore miss the infected side of the stem. Sterilisation of small sections of stem would overcome this difficulty but would take even more time.

So far as browning in the stem was concerned it soon became evident that it is impossible to distinguish it in the upper part of the stem where the vascular bundles are small and embedded in the ground tissue. In this respect *Verticillium* wilt differs from *Fusarium* wilt in which the darker colour of the bundles makes them more easy to detect.

It seems, therefore, that the only easily observable effect of the disease is the percentage of dead and yellow leaves. This has already been used by Bewley in his work on *Verticillium* wilt. Manurial factors may cause a certain amount of yellowing of the lower leaves but this can be allowed for by including uninoculated control plants in the experiment. The results of an experiment given in Table 1 shew how definite infection with a virulent culture produces a significant increase in the leaf symptoms. The number of infected plants was determined by re-isolation of the fungus.

Table 1.

Inoculum.	% leaves affected.	No. plants shewing browning.	No. plants infected.
Control	12.35	0	0
V. dahliae	6.45	0	4
V. albo-atrum ...	49.85	16	13
V. 186	14.45	0	3
V. 225	21.60	0	5
V. 243	42.32	16	16

(b) The infection of Manx Marvel and Riverside.

In the 27th Annual Report for 1941, an account was given of an experiment designed to test the reaction of certain resistant American varieties to *Verticillium*. The English variety Manx Marvel was also included. It was found that Riverside and Manx Marvel did not shew any appreciable degree of resistance when compared with Ailsa Craig and Potentate. The culture used was one isolated from tomatoes from Guernsey in 1939 and numbered V 243. It was thought that this culture might possibly be *V. dahliae* which also infects the tomato and is said to be commoner in warmer regions and *V. albo-atrum*. Unfortunately the type cultures of *V. albo-atrum* and *V. dahliae* in culture at the Station no longer produce the resting bodies characteristic of these two species so that it was impossible to be certain of its identity. There appeared to be a possibility that these two varieties might react differently to *V. dahliae* than to *V. albo-atrum*. Accordingly an experiment was set up in which Ailsa Craig plants were inoculated with the two type cultures V 243 and two other *Verticillium* strains in culture at the Station. The results of this experiment have already been given in Table 1. It will be seen that *V. albo-atrum* and V 243 were equally pathogenic to Ailsa Craig V 225 (isolated from tomato in 1934) also produced a significant amount of disease but less than the first two. *V. dahliae* produced no significant amount of disease.

The reactions of Manx Marvel and Riverside to the two cultures of *V. albo-atrum* and V 243 were then investigated. Sixteen plants each of Ailsa Craig, Manx Marvel and Riverside were inoculated with each of the fungi and arranged in groups of four in four randomised blocks. Freshly reisolated cultures were used. The results were as follows :—

Table 2.

Mean percentage of dead and yellow leaves.

Inoculum.	Variety.		
	Ailsa Craig.	Manx Marvel.	Riverside.
V. albo-atrum ...	34.2	22.9	21.2
V. 243	35.8	35.7	31.2

Analysis shewed that Manx Marvel and Riverside shewed significantly less disease than Ailsa Craig when inoculated with *V. albo-atrum* and no difference when inoculated with V 243. Ailsa Craig was attacked equally by both fungi : Manx Marvel and Riverside were significantly less resistant to *V. albo-atrum* than V 243.

This experiment suggests that the type of inoculum has a vital influence on the resistance of these two varieties. There are two possibilities, either V 243 is in fact *V. dahliae* or the change

in the culture of *V. albo-atrum* (saltation) which results in the loss of power to produce black resting bodies also affects the virulence of the fungus. Changes in virulence and other characters have been shewn to occur in saltants of the *Fusarium* wilt organism. That a permanent change has occurred in the culture of *V. albo-atrum* is shewn by the fact that carbonised hyphae are still absent after several inoculations and reisolations. These questions are now being investigated.

2. Tomato Leaf Mould (*Cladosporium fulvum*).

P. H. WILLIAMS.

During July and August specimens of Vetomold attacked by *Cladosporium fulvum* were received from several sources.

One of the growers concerned kindly forwarded samples of Vetomold seed, one being the original strain supplied to him in 1940 and the other a strain obtained by him direct from the Vineland Station in 1941. These were sown together with Ailsa Craig and Vetomold seed saved at the Station in 1942. The plants were sprayed with spores from the imported Vetomold leaves and on August 18th after about a month all shewed severe infection.

Later in the season the strains of Vetomold and Ailsa Craig were sprayed with spores taken from leaves from House 3 at the Station and also with spores imported with the original specimens of Vetomold. The two batches were kept in separate chambers in a greenhouse. Owing to the lateness of the season the disease was very slow in developing, but eventually both strains of Vetomold inoculated with the fungus from Vetomold developed spots on which the fungus spored. The Vetomold sprayed with spores taken from House 3 remained healthy. In both cases Ailsa Craig was attacked. It was noteworthy that the disease developed sooner in Ailsa Craig than on the two strains of Vetomold.

These results suggest that a strain of *Cladosporium fulvum* is present in this country which is capable of attacking Vetomold. Two such strains, Nos. 5 and 6, are known to exist in Canada, Vetomold being immune to strains 1 to 4. It is not known how widespread this strain may be and growers should not be deterred from growing Vetomold unless an attack actually develops. In that case, they should change to one of the other resistant varieties, details of which will be given on application to the Director of this Station.

3. A stem rot of tomato caused by *Didymella Lycopersici*.

ENID SHEARD.

During the early part of the present century "canker" caused by *Didymella Lycopersici* was fairly common in the glasshouse industry. It decreased in importance up to 1918 and since then

only occasional specimens have been received at the Experimental Station. In 1941, however, a serious outbreak occurred on one Lea Valley nursery, which, in spite of steam sterilisation, re-appeared in 1942. At the same time outbreaks were reported on nurseries in different parts of the country and later in the season the fungus was found to be the cause of much loss of outdoor plants and fruit.

The first sign of the disease appears as a dark brown lesion girdling the base of the stem just above soil level. The infected tissues sink below the general surface of the soil, the plant wilts and finally dies. Numerous small black pycnidia are produced on the surface of the lesion. The spores issue from the mouths of the pycnidia and can be seen as flesh coloured tendrils or small masses. The woody tissues of the stem are stained brown for some distance above the lesion and it is possible to isolate the fungus from the discoloured wood.

Secondary lesions occur higher up the stems. These are caused by air-borne spores from the primary lesions and may also be carried up during watering and trimming operations. The site of infection is frequently found to be a wound caused by careless trimming or rubbing by the string which supports the plant. Out of doors secondary infection occurs frequently in the axils of leaves.

Under very damp conditions small grey lesions are found on the leaves, which coalesce and kill the entire leaf. They were also found on the sepals, pedicels and fruit stalks of artificially infected plants.

Fruit infection rarely occurs under glass. Out of doors infected fruit may be accompanied by stem rot or the stems may be healthy and only the fruit infected. Infection may take place at any point on the surface of the fruit although it occurs most generally at the calyx end. The lesion at first appears water-soaked. Pycnidia are formed in the centre of this area and finally the fruit becomes covered with a black crust and falls to the ground. The fungus grows through the fruit and attacks the seeds which turn black with the dark-coloured mycelium and pycnidia.

Inoculation experiments were carried out with spore suspensions of *D. Lycopersici* to determine the ways in which tomato plants become infected.

It was found that unwounded plants were attacked most readily just above soil level. If, however, the stems were damaged by scratching with a scalpel, breaking off leaves, cutting out side shoots or by bruising with fillis infection occurred more rapidly at the site of the wound. This was confirmed by observations made in practice where basal infection was followed by infection through pruning wounds, especially where these had been made carelessly.

In further experiments infection occurred when the exposed ends of the peduncles were sprayed with spore suspension immediately after the fruit had been picked.

Infected stems were cut and the knife used to cut out side shoots from healthy plants. These plants rapidly became infected with stem-rot, shewing that infection may be carried with the pruning knife.

In addition to these methods, plants were successfully inoculated by dipping the roots into a spore suspension and planting in sterilised soil and by planting healthy plants in soil infected with a pure culture of the fungus or with a spore suspension.

Plants were found to be susceptible to the disease at all stages of development although infection took place most readily in older plants.

Healthy plants, four weeks old, were potted into artificially infected soil in 32 pots. At the end of eight weeks 90% of the plants had become infected with *D. Lycopersici.*

Tomato seeds were sown in artificially infected soil. 22% of the seedlings damped off and were found to be infected with *D. Lycopersici.* The seedlings were potted into sterilised soil and any shewing stem rot lesions were discarded (12%). By the end of eight weeks 12% of the plants potted up had become infected. Germination in infected soil was equal to that of controls in sterilised soil. All the control plants remained free from stem rot. It is possible, therefore, for seedlings raised from seed in infected soil to become infected with stem rot, and, furthermore, seedlings from such soil which on careful examination shew no signs of infection may develop stem rot at a later stage, even if they are planted out into clean soil.

The source of infection of the disease is not yet fully known. It is known that the fungus is capable of overwintering in the soil and it was shewn to be present on wire supports and strings removed from an infected glasshouse at the end of the 1941 season and kept out of doors throughout the winter. The soil, tomato plant remains, canes, wires and strings and the superstructure of the house must therefore all be regarded as potential sources of infection.

4. Virus Diseases

I. W. SELMAN.

During 1942, work has been directed mainly upon Tomato Mosaic virus disease, which remains one of the most serious and widespread of this group of diseases affecting the yield and quality of the tomato crop under glass. Two aspects of the problem have

been studied, firstly by investigation of the appearance and spread of the disease in commercial houses under various conditions and secondly by studying the environmental factors which affect the yield and fruit quality of diseased plants. Only an outline of the results can be presented here—full accounts will be published elsewhere.

The appearance of mosaic symptoms in a crop.

For a number of years, records have been made of the location of affected plants in houses on this nursery, together with the rate of spread of infection. In these studies no precautions were taken to prevent spread by cultural operations. A comparison has been made of the reactions of plants raised from virus-free seed with others growing in the same house, raised from infected seed.

In one experiment a house laid down to variety trials was studied. Six clean-seed varieties (248 plants) were distributed in plots at random in the house and their reactions were compared with 7 varieties distributed in the same house, but raised from infected seed (287 plants). No attempt was made to localise outbreaks of infection, the grower smoked cigarettes freely and the soil was not sterilised during the previous winter. Thus conditions were apparently ideal for the entry and spread of mosaic infection.

It was found that plants raised from infected seed shewed symptoms of mosaic infection earlier than did plants raised from virus-free seed. The incidence of mosaic symptoms is shewn in Table 1.

Table 1.

House 1. 1941.

Date.	Stage.	No. of plants with mosaic.	
		Infected seed.	Virus-free seed.
May 2nd		3	0
8th	3rd truss blooming	10	0
12th		16	0
17th		23	2
20th		36	2
26th		42	4
30th		67	7
June 6th	5th truss blooming.	94	25
13th		117	69
24th		198	149
	Total No. of plants. ...	287	248

Plant growth and fruit yield were not very good during 1941 in this house and in the following winter the soil was steamed. In 1942 a similar experiment was laid down, again comparing

plots of plants raised from clean and from infected seed. Favourable weather together with the steamed soil led to the production of exceptionally vigorous, well balanced plants and no mosaic symptoms appeared on any plant until the 6th truss was in bloom. Again no precautions were taken to prevent accidental infection of the plants with mosaic viruses. Under these conditions no differences in the date of appearance or the spread of mosaic could be observed in the two groups of plants studied.

It must be pointed out that steaming alone does not always give this control of mosaic infection in the early life of the crop, and from a study of soil factors in this connection, it has been concluded that a healthy root system, functioning under favourable soil conditions, is probably the chief factor determining this apparent resistance to mosaic infection, whether from external sources or from some obscure internal source via the seed.

In studies conducted over a three year period, it has become evident that it is usually impossible to ascertain, by inspection, the source of an outbreak of mosaic infection occurring under commercial conditions. Thus for example, the location of plants first shewing mosaic symptoms in a house, is commonly quite unrelated to any known vector or method of infection, and this can only be attributed to differences occurring between plants in their capacity to resist or localise small numbers of virus particles such as might be introduced by accidental contamination via smoking tobacco or infective debris in the soil.

The influence of Potash on the spread of Mosaic infection.

In an experiment designed to study the interaction of lime and potash fertilisation on mosaic-infected plants, 192 plants, variety ' Potentate,' were grown in ten inch pots at three levels of potash. The soil used was a rich old loam, but no bulky organic manure was included in the potting mixture. Each pot received 1 oz. dried blood and 1 oz. superphosphate per pot before planting, together with sulphate of potash at the following rates :

K_0 ... No potash
K_1 ... 1 oz. sulphate of potash per pot.
K_3 ... 3 oz. sulphate of potash per pot.

Top dressings were applied as required using these fertilisers only and in similar proportions.

One half of the plants were inoculated with Tomato Mosaic virus when the first truss was blooming on April 20th the remainder being uninoculated controls. The house was divided into four blocks each of which was subdivided, one half of the plants inoculated with mosaic and the other half being controls. Each half

block consisted of six plots for the manurial treatments and each plot consisted of four plants. The six plots were arranged at random within the half blocks and the virus treatments were arranged at random within the blocks.

The controls shewed no symptoms of mosaic until June 7th, when despite precautions, infection began to appear. On July 4th or 11 weeks after introducing virus into the house, all the control plants were tested for mosaic infection by inoculating test plants with extracted sap. No differences in the incidence of mosaic infection were found at two levels of liming but omission of potash gave significantly fewer infected plants than did inclusion of potash in the fertiliser thus :—

K_0	...	18	plants	virus-free	out	of	32	
K_1	...	4	„	„	„	„	„	„
K_3	...	3	„	„	„	„	„	„

The soil was initially quite rich in potash and the series K_0 gave exceptionally vigorous and leafy plants and produced the heaviest crop of fruit.

Controls. Fruit Yield from 5 trusses.

(Means of 32 plants.)

K_0	...	6 lbs. 7 ozs.
K_1	...	5 lbs. 12 ozs.
K_3	...	4 lbs. 9 ozs.

The yield reduction induced by inoculation with the tomato mosaic virus was of similar magnitude in the three treatments viz. approximately 20% of the yield of the controls.

That the high incidence of mosaic on plants receiving sulphate of potash may be associated with an internal deficit of water in the plant, was suggested by the relative incidence of Blossom End Rot on the fruits. This disorder is commonly attributed to lack of water in the plant. Potash manuring, under the conditions stated above, tended to increase the amount of Blossom End Rot, although this was almost entirely confined to the first two trusses.

% of fruit by wt. shewing blossom end rot.

		Controls	Infected
K_0	...	0.7	0.3
K_1	...	4.0	2.7
K_3	...	7.0	6.4

The above results, although obtained under special conditions, do suggest that some control of mosaic infection might be obtained by reducing the dressings of potash which are normally applied,

so far as the variety Potentate is concerned. On old and heavily fertilised tomato soils however, no serious fall in crop is to be anticipated from such treatment.

Crop yield and Mosaic infection.

The experiment referred to above, was designed to investigate the influence of lime and potash fertilisation on the crop yield of mosaic-infected plants, but under the conditions of the experiment no evidence could be obtained that the relative effect of mosaic disease varied under differing manurial treatments.

The most successful result from the cropping point of view with plants infected with tomato mosaic virus when the first truss was in bloom, was obtained from plants grown without the addition of fresh lime (old lime residues were present however) and where 1 oz. of sulphate of potash per pot had been added as base dressing. From 5 trusses a yield of 5 lbs. 5 ozs. per plant was obtained (Mean of 16 plants) of which 3 lbs. 10 ozs. was unblemished ripe fruit. Uninoculated controls with similar manures yielded 6 lbs. 5 ozs. per plant of which 5 lb. 3 ozs. was unblemished, ripe fruit.

Whilst it is not suggested that the manurial dressings were balanced ideally or that the soil texture was good, it is evident that quite profitable crops can be obtained by ' growing on ' mosaic-infected plants even where infection occurs at a very early stage. The practice of rogueing mosaic-infected plants can generally be regarded as an uneconomic proposition, particularly in war-time.

Production of a Mosaic-free crop.

Although our knowledge of mosaic control is still incomplete, the following notes may prove helpful to growers who are attempting the production of crops free from mosaic virus diseases. Most of the work to date has been carried out with the variety ' Potentate ' ; how far such a scheme can be applied to other varieties is uncertain but with slight modifications it may prove applicable to tomato culture generally.

The problem may be resolved into two parts thus :

(1) Control of Source of Infection.

(*a*) The use of virus-free seed taken from well-nourished vigorous plants free from mosaic mottling must be regarded as an essential prerequisite to the production of a virus-free crop. Seed should only be taken from unblemished, soft-ripe fruit.

(*b*) Smoking should not be permitted by workers handling plants. The importance of this source of infection has probably been overstressed in the past, but it remains a potential source of infection.

(*c*) Infective debris in the soil remaining from earlier crops should be inactivated by steaming or by the use of formalin. The importance of soil sterilisation lies more, however, in the production of vigorous, strong rooting plants which may resist chance infection.

(2) Control of Culture.

A vigorous, free-growing plant has been found to possess the capacity to localise or resist infection by small numbers of virus particles, such as may be introduced by chance, in cultural operations. It is therefore essential that *no check to growth be permitted at any stage of development.* Potential sources of danger may be listed as follows :—

(*a*) Dry soil.

(*b*) Low temperatures.

(*c*) Dry atmosphere.

(*d*) Deficiency of mineral nutrients or unbalance of minerals which hardens the plant.

(*e*) Excess of soluble fertilisers designed to harden the plant suddenly e.g., sulphate of potash.

(*f*) Root diseases, fungus and animal.

Most, if not all, of these factors tend to affect growth by inducing a shortage of water within the plant either directly or indirectly.

Where growth factors are uniformly favourable to the plant, the dangers of seed, smoking tobacco, or Tomato debris as infection centres are materially lessened.

With varieties other than those of the ' Potentate ' class it is common practice to apply potash freely at certain stages of development to facilitate fruit set and induce balanced growth. Such a process of ' hardening ' is not generally considered to be essential with ' Potentate ' and with this variety may tend to increase the incidence of mosaic infection. Applications of potash with this variety should probably be limited to supplying the basic growth requirements of the plant and not in quantity sufficient to check growth.

Potash deficiency must of course, be guarded against, but where small dressings of sulphate of potash are applied to an old tomato soil, this is unlikely to supervene.

5. A fruit blemish of outdoor tomatoes (Stonor's varieties).

ENID SHEARD.

During the 1941 tomato season numerous specimens of outdoor tomatoes, all of Stonor's varieties, were received which bore pale brown spots, irregular in outline and with a well-defined margin, varying in size from small spots to blotches covering a third of the area of the fruit. Closer examination shewed that the lesions were not uniformly brown but had the appearance of a darker brown network on a pale ground. Apart from the discoloration there was no other change in the surface of the fruit unless a secondary infection had occurred. In some cases it was possible to ascertain that the trouble was confined to the bottom two trusses of the plants.

No organisms could be isolated from the lesions and it was thought at first that the trouble might be a form of *Botrytis* spot.

Inoculation experiments with Botrytis.

Throughout the experiments, unless otherwise stated, the plants used were Stonor's M.P. grown in " 32 " pots.

Trusses of young tomato fruit susceptible to *Botrytis* spot (see this Report for 1937) were atomised with a spore suspension of *B. cinerea* in tap water under the following conditions :—

1. Inoculated trusses enclosed in flasks for 24 hours ; plants in a glasshouse.
2. Inoculated trusses enclosed in flasks for 24 hours ; plants in a glasshouse. After removal of the flasks plants placed out of doors.
3. Inoculated trusses enclosed in flasks for 24 hours ; plants out of doors.
4. Inoculated trusses not enclosed in flasks ; plants under glass.
5. Inoculated trusses not enclosed in flasks ; plants under glass for 24 hours, then placed out of doors.
6. Inoculated trusses not enclosed in flasks ; plants out of doors.

The experiment was repeated on three occasions. *Botrytis* spots ranging from the typical pale green rings surrounding brown central punctures to small dark green spots with brown centres were produced by the inoculations. In no case was the fruit blemish produced.

Experiment with Sprays.

As spraying against Blight had been carried out extensively in 1941 there was a possibility of the blemish being a spray injury.

Tomato fruit of all sizes were sprayed under the same conditions as in the *Botrytis* experiments, using Bordeaux mixture, Burgundy mixture and proprietary preparations containing copper oxychloride and cuprous oxide, with and without oil emulsion.

The majority of sprayed fruit remained unmarked. A few fruit, however, shewed a small number of dark green flecks at the calyx end with all the sprays used.

Effect of exposing fruit to a saturated atmosphere.

Trusses bearing small fruit and flowers were atomised with distilled water and enclosed in flasks plugged with cotton wool. Half the plants were kept in a glasshouse and the rest placed out-of-doors.

After five weeks the flasks were removed and the following marks observed on the fruit :—

Small cracks chiefly at the calyx end

Oedematous spots

Blossom-end rot

Botrytis rot

Botrytis spot

The blemish did not appear on any of the fruit.

At the end of April plants of Stonor's M.P., growing in 12" pots were placed out of doors and a similar number kept in a glasshouse. The plants were kept under observation until the end of the season.

Botrytis spot occurred on the fruit under glass while blossom end rot, *Botrytis* rot, *Botrytis* spot, *Didymella* fruit rot and streak appeared on the fruit out-of-doors. The fruit blemish, however, was not seen.

From these experiments it is concluded that the fruit blemish of Stonor's varieties of tomato is neither a form of *Botrytis* spot nor a spray injury. It seems possible that the damage is due to certain weather conditions, or a combination of these, which are as yet unknown.

6. Didymella (Tomato Stem-rot) Investigations.

W. H. READ.

Outbreaks of Tomato stem-rot, caused by the fungus *Didymella lycopersici*, have caused serious losses on several nurseries during the past few years. Furthermore it is evident that this disease is prevalent on outdoor tomatoes in many districts and may prove more serious than " late-blight " of tomatoes caused by the fungus *Phytophthora infestans*. The nature of the disease and the causal organism is described by Mrs. Sheard (page 30).

In spite of the importance of this disease in other countries, there appears to be no satisfactory method for its control. The problem has therefore been approached in three ways ; the treatment of the soil to destroy the fungus therein, the treatment of plants with protective fungicides to prevent attack, and the treatment of the lesions or ' cankers ' on the plants to prevent the death of plants attacked.

In view of the heavy loss of plants occurring on affected nurseries, the possibility of killing the fungus on the plant was investigated at first. Although the disease usually commences on tomato stems at soil level, lesions occur higher up on the stems where they may be confused with those caused by *Botrytis*. Cutting out these lesions and painting the wound with liver of sulphur or rubbing it with a crystal of copper sulphate, as is done to control *Botrytis* stem rot, proved valueless, for unless all the discoloured portion of the stem was removed the fungus continued to develop. Complete removal usually makes too severe a wound, even where the treatment was applied immediately the disease was detected.

Tomato plants, inoculated with *Didymella* at the base of the stem, were also treated with various fungicides, although the previous work suggested this was unlikely to yield successful results owing to the growth of the fungus within the tissues of the plant. The plants which were about three months old, were inoculated by spraying a suspension of *Didymella* spores on to the stems of the plants at soil level after slightly scraping each stem in one or two places, and placing the plants in a moist chamber for 48 hours. Almost every plant inoculated in this manner became diseased but plants sprayed with spores without having their stems wounded, often failed to contract the disease. When the lesions or " cankers " were easily visible the collars and lower portions of the stems of the plants were sprayed with the fungicides. Approximately 2 fluid ozs. of the liquid were applied to each plant so that the soil surrounding the collar was also wetted. The substances and maximum stengths at which they were applied were :—Mercuric chloride 0.5%, Lime sulphur 10%, Copper sulphate 0.5%, Malachite Green

0.25%, Potassium permanganate 1%, 5% copper naphthenate in pine oil emulsion 2%, Uspulun 1%, 15% copper oxychloride suspension 2% in combination with petroleum emulsion 4%, Bordeaux mixture 5%.

None of these treatments arrested the development of the disease. Healthy tomato plants were killed by the copper naphthenate emulsion and damaged by 0.5% mercuric chloride and 1% potassium permanganate.

Soil Treatments.

It has been shewn elsewhere that *Didymella* attack may occur where tomatoes are grown in infected soil. The cessation of outbreaks of the disease following severe attacks many years ago has been attributed to steam sterilisation of the soil. The losses of plants on nurseries in 1942 were exceptionally heavy, however, where steam sterilisation had been carried out the previous winter. The resistance of the fungus to heat was determined therefore, and it was found that infected soil was freed of the fungus by heating to 122°F. for 10 minutes. Although the uniform heating of the soil obtained in laboratory experiments is unobtainable in the commercial sterilisation of tomato borders, there is little doubt that the process of steam sterilisation, as normally conducted, should destroy the fungus in the soil of glasshouses. There is some evidence, however, that the type of growth frequently induced when growing tomatoes in steam sterilised soil renders them more susceptible to disease.

Tests were also made to find the concentrations of formaldehyde, cresylic acid and a proprietary emulsion of tar acids of higher boiling point than cresylic acid, which would destroy the fungus in the soil. Under the conditions of a standardised laboratory method it was found that 48 hours contact with formaldehyde at 1 in 1,000, cresylic acid at 1 in 850 and the proprietary emulsion at 1 in 430 destroyed the fungus. Although these results cannot be attained in the commercial sterilisation of soils with fluid sterilising agents they shew that the fungus is susceptible to the usual chemical sterilising agents. Trials are being made in which these sterilising fluids have been applied in a commercial manner to tomato borders heavily infected with *Didymella*.

Protective treatments for the bases of stems of plants.

Many tests were made on plants grown in pots in an endeavour to find a treatment to protect the collars of plants from attack. This aspect of control differs somewhat from the protection of fruit, leaves and stems since substances which would cause injury to the aerial portions of plants can in many cases be applied to the base of the stem, i.e., " collar " of the plant, without damage.

The method first adopted for infecting plants was to spray suspensions of *Didymella* spores on to the stems at soil level. Unfortunately the fungus frequently attacked only a few of the plants and complete series of tests proved valueless owing to the failure of the fungus to develop on plants which were untreated with fungicides. In later tests the method adopted was to apply a thin layer of soil, mixed with 10% of its bulk of a sand—oatmeal culture of *Didymella* to the soil in the pot after treatment with the fungicide. This system of inoculation gave much more satisfactory results.

No fungicide has been found which gave protection to the collar of plants with a single application. A number of substances appeared to give complete control as a result of a single test but failed completely, and in some cases increased the amount of infection in other tests. It is evident that cultural factors have a pronounced influence on the susceptibility of plants to attack by *Didymella*.

The following were tried at different concentrations but did not give control of the disease under the conditions of the experiments; the concentrations given are the highest employed in a number of tests.

Mercuric chloride, 0.2% cresylic acid 1%, copper sulphate 0.4%, lime sulphur 10%, malachite green 0.25%, cuprous oxide suspension 1% Cu, calcium bisulphite solu. (D. 1.07) 2%, proprietary tar acid emulsion 0.25%, Cheshunt compound 1.25%, Shirlan H.B. 1%, Bordeaux mixture 5%, Uspulun 1%.

Although single applications of these failed to prevent loss of plants a number have been selected for further trials in which frequently repeated applications are to be made.

Protective treatments for stems, fruit and leaves.

Infection of the upper parts of the stems of otherwise healthy tomatoes frequently follows initial attacks at the collars of other plants, whilst on outdoor tomatoes stems, fruits and leaves may be attacked. In trials with protective fungicides conducted on pot plants under glass difficulty was again encountered owing to the unsatisfactory " take " of inoculations. The usual seats of infection of the upper portions of the stems of tomato plants in glasshouses are wounds made by trimming or where the string rubs the stem. In these tests, designed to find a protective fungicide to prevent infection at these points, leaves and side shoots were cut from the plants with a sharp knife an hour before spraying the plants with the substance under test. When the sprayed plants were dry they were again lightly sprayed with a suspension of spores of *Didymella*. In several tests unsprayed plants remained unattacked whilst the sprayed plants were badly infected.

No treatment gave the desired degree of protection. All the standard fungicidal sprays applicable without much damage to tomatoes were tried.

The fungus appears highly resistant to the action of fungicides in the presence of plant juice since if a spore suspension is placed on a wound freshly made with a sharp knife and immediately treated with pastes of Bordeaux mixture, 5% lime sulphur, flowers of sulphur or lime, infection of the plant frequently follows.

A survey made on October 10th of the outdoor tomato plants shewed that none of the spray treatments, enumerated on pages 44 and 45 had significantly influenced the amount of fruit affected with *Didymella*. No plants were destroyed by " collar " attack but many had lesions on their stems.

The fungus did not attack the fruit until late in the season and the point of initial infection was either under the calyx or in cracks, both sites being difficult to protect with fungicides.

7. Fungicides for the control of " Late-Blight " (*Phytophthora infestans*) on Tomatoes.

W. H. READ.

" Late-blight " is frequently a serious disease on outdoor tomatoes and in view of the great increase in this crop due to wartime conditions, spray trials have been made to find the most suitable fungicide for controlling this disease.

Two series of trials were made.

Series A.

Fungicides containing copper compounds have proved effective as protectants on potatoes against blight caused by *Phytophthora infestans*.

The usual amount of copper in the spray fluid for this purpose is 0.25% copper. In this trial the effect of two applications of sprays and dusts found effective for potatoes has been compared with two applications of the same compounds at reduced strength and with two sprays not containing copper.

Plots at the Research Station containing 74 tomato plants were sprayed on July 30th, and August 27th with the mixtures enumerated later using a spraying machine working at a pressure of 80 lbs. per sq. in. and a nozzle giving a misty spray. Dusts were applied with a hand operated machine. Approximately 2½ gallons of spray and 5 ounces of dust were required to treat each 74 plants.

Owing to the limited amount of ground available for outdoor tomatoes at the Research Station it was necessary to superimpose these trials on the variety trials.

Fungicides used and strengths at which applied.

(*a*) Bordeaux mixture—prepared in the proportion of 10 lb. bluestone (copper sulphate) and 12 lbs. hydrated lime to 100 gallons. Applied at 0.25% copper, in the spray fluid.

(*b*) A proprietary cuprous oxide preparation of 50% copper content. Applied at 0.25% copper.

(*c*) A proprietary copper oxychloride preparation containing 50% copper.
Applied at 0.25% copper.

(*d*) A copper-lime dust of 15% copper content.

(*e*) A proprietary cuprous oxide dust containing 17.5% copper.

(*f*) A proprietary copper oxychloride paste containing 15.5% copper, together with a "white-oil" emulsion.
The spray fluid containing 0.05% copper and 0.5% petroleum oil.

(*g*) Substance (*b*) together with a "white-oil" emulsion.
The spray fluid containing 0.125% copper and 0.5% petroleum oil.

(*h*) Substance (*c*) together with a white-oil emulsion.
The spray fluid containg 0.125% copper and 0.5% petroleum oil.

(*i*) A proprietary paste containing 50% salicylanilide. The spray fluid contained 0.1% salicylanilide and a wetting agent to give efficient wetting of the foliage.

(*j*) A proprietary petroleum oil emulsion containing salicylanilide. Applied at a dilution of 1 in 80.

Several plots were left unsprayed for comparison.

Series B.

In this series of trials the effects of repeated applications of various fungicides were compared. Where potatoes are sprayed to control blight it is unusual to give more than two applications during the season, but, owing to their more continuous growth, tomatoes may need more applications. Furthermore the greater value of the tomato crop justifies the increased cost and labour of more frequent sprayings. Failing further information growers have been recommended to apply protective fungicides every 2-3 weeks from July onwards and the problems of injury to the plants and spray deposits on the fruits resulting from this frequent spraying were investigated. Plots of ten plants were thoroughly sprayed with

a knapsack type sprayer to wet both upper and lower leaf surfaces. The dusts were applied with a hand bellows duster early in the morning whilst the plants were damp. Each plot contained the varieties Potentate, Radio, E.S.I. and Early Market. The dates of application were July 13th, 28th, August 10th and 27th, and September 17th.

Fungicides used and strengths in which applied.

The sprays and dusts *a-f*, employed in Trial A were used in this series and the following in addition.

(*k*) Bordeaux mixture—mixture (*a*) at half strength. Copper content of spray 0.125% copper.

(*l*) Bordeaux mixture—prepared in the proportion of 10 lbs. bluestone, 6 lbs. hydrated lime to 100 gallons water. Copper content of spray 0.25%.

(*m*) Bordeaux mixture—half strength of (*l*).

(*n*) Burgundy mixture—prepared in the proportions 10 lbs. bluestone and 12½ lbs. washing soda to 100 gallons water.

Copper content of spray 0.25%.

(*o*) Cuprous oxide (*b*) at half strength i.e. 0.125% copper in spray.

(*p*) Copper oxychloride (*c*) at half strength i.e., 0.125% copper in spray.

(*q*) Cuprous oxide (*b*) together with a white oil emulsion—half the copper content of (*g*) i.e., 0.063% copper and 0.5% petroleum oil in the spray.

(*r*) Copper oxychloride (*c*) together with a white oil emulsion—half the copper content of (*h*) i.e., 0.063% copper and 0.5% petroleum oil in the spray.

(*s*) An experimental copper oxychloride dust containing 20% copper.

Results.

None of the plots in either trial, sprayed or unsprayed, became infected with blight, even though those in series (*b*) were twice sprayed with a suspension of spores of the fungus, obtained from diseased tomato fruits. This is attributed to the weather being unsuitable for the development of the disease and it is of interest to observe that the disease was absent on nearly all the County Trial plots mentioned elsewhere. Owing to the absence of heavy rains after the second application of sprays to both series, deposits on the fruits were probably heavier than they would be in a normal year. The following facts emerged from the trials, however.

Effects on the plants.

The Bordeaux mixtures (*a*), (*k*), (*l*) and (*m*) hardened the plants and this effect was particularly noticeable in one trial where plants were sometimes dry at their roots. The low lime Bordeaux mixture (*l*) caused as much hardening as the more normal mixture (*a*). The deposits on the fruits from all the Bordeaux mixture sprays were heavy and necessitated wiping the fruit before marketing as the result of a single application. The Burgundy mixture (*n*) caused considerable leaf scorch and also caused considerable deposit on the fruit.

Cuprous oxide sprays (*b*) and (*o*) caused some hardening of the plants, particularly at the higher concentration. The deposit from two applications of these sprays necessitated wiping the fruit. Addition of an oil emulsion to cuprous oxide sprays (*g*) and (*q*) eliminated the hardening effect of this material but did not appreciably reduce the visibility of the deposit.

Considerable deposit remained on the fruits from the copper oxychloride sprays (*c*) and (*p*), particularly the former. No hardening of the plants was observed from the use of these. The addition of a white oil emulsion reduced either the visibility or amount of deposit on the fruits so that wiping was unnecessary.

The dusts containing cuprous oxide (*e*), copper oxychloride (*f*) and copper lime (*d*) when first applied at the stated rate made it necessary to wipe the fruit before marketing but they were more readily washed from the fruit by rain. A heavy rain after the first application reduced the deposit to a tolerable limit.

The copper oxychloride paste—petroleum emulsion mixture (*f*) caused only very slight marking at the blossom end of the fruits and wiping the fruit was unnecessary. The spray containing 0.1% salicylanilide (*i*) caused no hardening of the plants and the amount of deposit on the fruit resulting from two applications of the spray was not sufficiently noticeable to necessitate wiping the fruit. No injury to plants was caused by the petroleum emulsion—salicylanilide spray (*j*) and there was no visible deposit on the fruit.

No determinations by chemical analysis of the actual amount of deposit were made.

Fruit Injury.

Examination of the fruits picked from the plots in Series B in September and the first week in October shewed that there was slight damage to the skin of the fruits on all plots both sprayed and unsprayed. The injury was shewn as small brown necrotic spots confined to the skin only. Sprays containing copper appeared

to increase the damage proportionally to their copper content. The incorporation of petroleum oil emulsions reduced this damage. No explanation of the cause of this damage can be given.

Didymella.

Fruit rot due to the fungus *Didymella lycopersici* was prevalent on all the sprayed and unsprayed plots at the end of the season.

The disease also attacked the foliage of many plants and lesions were found on several stems. Although there were considerable variations in the severity of this disease on different plots this was not due to the fungicidal action of the sprays since with several substances the plants were most severely attacked where the highest concentration was used. Unsprayed control plots also shewed wide variations in severity of attack.

3. Animal Pests,

1. Eelworms (*Nematoda*).

E. R. SPEYER.

(a) Experiments with Potassium iodide on Root-knot Eelworm.

Into three boxes a compost containing infected soil and noduled roots was introduced early in March. One box acted as an untreated control, to the second a solution of potassium iodide 1 part in 2,400 parts of water was applied at a rate equivalent to 30 gallons per 100 sq. yds. surface at each application and to the third a similar solution at a rate equivalent to 120 gallons the latter being four times the amount which has been applied on certain commercial nurseries.

Tomato plants (var. E.S.1.) 4½ to 5½ inches high were planted in the boxes fourteen days after the first application : a second application followed two weeks after planting, and a third after a further period of eight weeks. With the exception of a few removed from time to time for examination of the roots, the plants were grown until the end of August.

The lower foliage of the plants in both treated boxes shewed some slight injury after the second, but not after the third application when the plants were older. The growth was sturdy, and six weeks after the last treatment all the plants, both treated and untreated, had set seven trusses and attained to a height of 4½ to 5 feet.

Upon the day previous to the last application, the roots from one plant in each box were examined : minute nodules were present upon all of them. Six weeks later large numbers of nodules had formed. The remaining plants were allowed to grow on for a further period of seven weeks and then examined. Upon the control plants and on the plants which received the smaller quantity of solution, the nodules were small and numerous Many larger galls were present upon the roots of those which received four times the quantity of solution at each application.

(b) Effects of chemical solutions upon some soil-inhabiting Eelworms.

The movements of Root-knot Eelworm (*Heterodera marioni Cornu*) become slow and irregular after the larva has entered the roots of plants, and it is therefore difficult to determine whether or not they have been killed by immersion in chemical solutions. When pieces of noduled roots were kept for some days in soil, they were invaded by active free-living nematodes of the genera Rhabditis and Cephalobus, and a large number of recently hatched larvae of Root-knot Eelworm, which shew considerable activity, were also present. Small sections of such material were placed in

glass capsules containing various chemical solutions and removed from them to tap-water after varying periods of time. A large majority of the eelworms remained active for a period of at least seven days in both tap and freshly distilled water.

Formaldehyde (36%) 2% solution :—

Nearly all eelworms motionless in 5 minutes, all in 8 minutes. No recoveries after immersion for 15 minutes.

0.5% solution :—

All motionless in 38 minutes : some 25% recovered after immersion for 68 minutes. No recoveries after immersion for 24 hours.

0.1% solution :—

Majority motionless in 18 hours : a few still moving after 67 hours.

Emulsified cresylic acid (75% phenols). 1% solution :—

All motionless in 2 minutes : no recovery after immersion for 5 minutes.

0.1% solution :—

Results variable. In some tests nearly all became motionless in from 1½ to 2 hours, but nearly all recovered after transference to fresh water, and some also recovered after 5 hours immersion. In one test 3 out of 24 eelworms remained active for more than 40 hours, while in another none recovered after immersion for 18¾ hours. Six eelworms which recovered after 66 hours immersion all belonged to the genus Cephalobus : the variable results obtained were therefore probably due to the kind of eelworm subjected to treatment.

Potassium iodide 0.1% solution :—

Some eelworms alive and active after 72 hours immersion.

Nicotine (98%) 0.05 and 0.1% solution :—

The eelworms which became strongly contorted on immersion retained powers of movement for from 60-70 hours but did not recover after 90 hours' immersion. Eggs hatched to active larvae after 42 hours' immersion in the stronger solution.

Thymol Saturated solution (about 0.09%)

Whereas some eelworms became motionless in 2 minutes, and no recoveries took place after 5 minutes' immersion, a few (including larvae of *H. marioni*) shewed movement for as long as 1 hour. Some were killed in 5 minutes while others recovered after 1½ hours' immersion.

All were killed by 4 hours' immersion. Out of a total of 64 eelworms immersed for periods varying from 5 minutes to 19 hours, only 4 recovered after transference to fresh water.

A solution of sodium thymolate containing 20% thymol has a similar lethal action upon these Nematodes when used at a concentration of 1 part in 220 parts hard water. The effect of this compound is being tested upon tomato plants grown in soil containing Root-knot eelworm.

Dr. T. Goodey has given valuable information upon these Nematodes, and thanks are also proffered to him for his kindness in determining the identity of those dealt with in the experiments.

2. Red Spider Mite (*Tetranychus telarius* L.).

E. R. SPEYER.

Spraying Experiments :—

Sprays containing tartar emetic with glycerine or molasses have been used experimentally in U.S.A. for the control of the mite on cucumber and carnation plants.

When applied to the foliage of infected tomato pot-plants (variety E.S.I.) the following results were obtained :—

To 100 gallons water		% mortality of mites		
Tartar emetic	Glycerine	Active stages	Resting stages	Injury to foliage
lbs.	gallons			
4	3	73	86	Severe
4	–	61	24	None
2	3	60	50	Severe
2	–	47	50	None
–	3	60	60	Severe
–	0·25	0	0	Considerable

Very similar results were obtained when cane molasses at the rate of 1 gallon or flour paste at the rate of 4 lbs. to 100 gallons water was used in conjunction with tartar emetic. The mortalities obtained were considerably lower than those recorded by American workers, and not high enough to warrant the use of these sprays as a means of control. Numbers of mites were killed both by tartar emetic used alone and glycerine used alone, the latter being responsible for much injury to the foliage of tomato plants ; the two used in conjunction with one another did not lead to any significant increase in

mortality of the mites. It is noteworthy that glycerine at low concentrations was injurious to the foliage and it was found that tartar emetic could be applied at rates up to 10 lbs. per 100 gallons water without causing injury but without increased effect upon the mite. Addition of wetting agents such as saponin and Agral to tartar emetic solutions and glycerine solutions tended to decrease rather than increase the percentage mortality of mites. None of the sprays used had any effect upon the eggs of the mite. The possibility of tartar emetic acting as a stomach poison was investigated. Uninfected tomato plants and separate leaves from them were sprayed with tartar emetic at rates of 2 up to 10 lbs. per 100 gallons water to which 1 gallon cane molasses or 4 lbs. flour paste were added. After application the plants and leaves were allowed to dry, considerable deposits not easily removed being left upon them by the sprays, and were then placed in contact with several infected leaves for a period of 2 days. Leaflets were examined on alternate days for a period of a week, when in all cases feeding marks upon the foliage had become numerous. With cane molasses and tartar emetic mortalities of the mites obtained upon plants varied from 8% to 26%, on separate leaves from 17% to 28%; with flour-paste and tartar emetic they were 6% to 11% and 6% to 12.5% respectively. As the mortalities upon unsprayed plants and upon leaves sprayed with water varied from 4% to 13%, it was concluded that tartar emetic had at most a slight effect as a stomach poison, and that its action upon the mites was chiefly one of contact.

The thanks of the Experimental Station are due to Messrs. Allen and Hanbury Ltd., for kindly supplying solutions containing a compound analogous to tartar emetic with wetting agents of the sulphonated type.

With some of these mortalities of from 60% to 79% were obtained without injury to the foliage. At higher concentrations mortalities of 80% to 100% resulted with injury to the foliage ranging from slight to severe. In the majority of the cases the mortality was found to be due mainly to the action of the wetting agent, the addition of the antimony compound resulting in an increase of only 3% to 8%.

Autumn fumigation of tomato houses.

There exists considerable diversity of opinion as to the efficacy of naphthalene fumigation or of burning sulphur shortly before the plants are removed at the end of the crop, as a means of preventing attack by the mite in the following growing season. It should be pointed out that in the past no claim has been put forward that either of these methods is likely to prevent attacks or materially to lessen the extent of mite infection if applied at a time after the mites have begun to find their way into crevices of the glasshouse structure in which they overwinter, i.e., in mid-September at latest.

The following record from experiments and from observations upon a commercial nursery gives evidence that such fumigations carried out after this time have but little value, and if practised solely for the prevention of future mite attacks are likely to result in waste of time and material.

(i) Naphthalene :—

(*a*) October 20th : house of 1,400 c. ft. capacity containing infected pot-plants 3 feet high ; 1 lb. naphthalene volatilized from a lamp at 10.30 a.m. Volatilization complete in 7 hours : temperature between 60° F. and 70°F. (outside temperature 50-59° F.). Vents kept closed until following morning.

During a period of seven days after fumigation mites recovered after temporary anaesthesis, a mortality of 87% being finally recorded. Allowing for a natural mortality of at least 15% at this time of year and the fact that hibernating mites were in the minority upon these young plants, the mortality obtained is not considered high.

(*b*) October 29th : House of 13,000 c. ft. capacity containing old and severely infested plants. " Grade 16 " naphthalene broadcast, after damping of the soil surface, at the rate of 1 lb. per 1,000 c.ft. space. Duration of fumigation, 96 hours, temperature 62° F.—90° F., atmospheric humidity 70%—85% : mean temperature at soil surface 65° F. After 48 hours' fumigation, 41% of the mites upon the foliage, and 29% of the hibernating mites in crezices in the stems of plants were dead in samples taken at random from different portions of the house. After 96 hours a total mortality of 36% was recorded.

(ii) Sulphur dioxide.

(*a*) October 29th : house of 13,000 c.ft. capacity adjoining and in all respects similar to i(*b*) above—33 lbs. sulphur, equivalent to 2½ lbs. per 1,000 c.ft. burnt in eight heaps which took from two to three hours to burn out. Temperature 64° F.—90° F. Vents kept closed till following morning. All adult mites upon the foliage were killed, but some young forms in the resting stages survived : amongst the hibernating mites in crevices upon the plant stems there was a mortality of 82%. (*b*) October 9th : block of houses on commercial nursery : sulphur burnt at the rate of 1 lb. per 1,000 c.ft. space. When examined 4 days after fumigation the foliage was dry and such mites as had remained upon it were dead : of hibernating mites in crevices upon the plant stems, only 23% were dead.

(*c*) October 12th : as ii(*b*). Examined on day after fumigation nearly all mites upon the foliage were dead, but only 30% of those hibernating in crevices upon the plant stems were killed.

From the above observations it would appear that the broadcasting of naphthalene is practically useless at this time of year when it is not economic to maintain a temperature above 70° F. over a long period of time: that the burning of sulphur even in comparatively large quantities and volatilization of naphthalene from lamps leaves sufficient mites alive to initiate an infestation during the following season.

The burning of sulphur has the merit of drying up the old plants, so that they can be more readily disposed of when they are removed from the houses.

When recommendations were made for the fumigation of cucumber houses by broadcasting " Grade 16 " naphthalene some 18 years ago, it was pointed out that such fumigations were not likely to be successful if a high atmospheric humidity was not maintained and if temperatures were allowed to fall below 74° F. for any length of time during fumigation which had to be extended over a period of 24—36 hours.

An experiment recently carried out gives further evidence of the validity of this contention and appears to shew that the duration of fumigation necessary to kill the red hibernating mite is longer than that required to destroy the summer form.

An Arum plant, severely infested with both forms of mite, was enclosed in an air-tight cage of 10 c.ft. capacity, the floor of which had been covered with well-moistened sand and 3 ozs. of naphthalene distributed over the latter. An atmosphere near saturation both with water and naphthalene vapour was thus obtained. Temperatures ranged from 60° F. to 69° F.

Upon some leaves removed between 17 and 18 hours after the start, with temperature 60°—64° F., all mites recovered within 24 hours after their removal. Infested tomato leaves were introduced into the cage for a period of 76 hours, during which the temperature was practically constant at 69° F.: both summer and hibernating forms recovered within a period of 17 hours following their removal.

After 43 hours' fumigation the arum plant was removed from the cage ; no summer forms of the mite recovered, out of a large number of hibernating forms only three shewed slight movement on the second day after their removal, but these died subsequently. Whereas a period of 43 hours' fumigation killed all the summer forms, it appeared that this period was only just sufficient to destroy the red hibernating mite at these temperatures.

Such a high degree of saturation with naphthalene vapour could not be obtained in a glasshouse. Incidentally the arum plant was uninjured by the fumigation and has remained free of mites for a period of four months, during which it has flowered.

3. Wireworm Investigations.

E. R. SPEYER and W. J. PARR.

In an attempt to obtain some information upon the movements of Agriotes larvae towards baits buried beneath the soil surface, large slices of carrot were stuck into the ground to a depth of about four inches in the loam soil of a glasshouse near Berwick. The glasshouse, in which lettuce crops had been destroyed by wireworms previously, was being used as a propagating house, and a minimum night temperature of 52° F was maintained ; the soil had lain fallow for some months. During the observations, which were carried out in December and January, it was found necessary to water the soil periodically, otherwise the wireworms did not assemble at the baits.

Upon an area of 27 square yards, 124 carrot baits were left in the ground for a period of five days, when 341 larvae were collected from them: of these about 90% were in close proximity with, or had actually tunnelled into the baits, the remainder in the soil within a radius of three inches from each. One adult *Agriotes* sputator L was found in the soil. The area was left unbaited for eight days, and then twelve baits were set in the middle of the plot : after a period of five days, eighty-eight wireworms were collected from them, indicating that the wireworm population had not been materially reduced by the first trapping.

Upon a second plot, twenty-four baits were set out in six rows, 3 feet apart, the four baits in each row being at a distance of two feet from one another. The larvae were collected from them, and from the soil within a radius of three inches from each at intervals of four days with the following results :—

Table 1.

Periods	Wireworms assembled.		
	At baits	In soil	Total
1	41	35	76
2	56	12	68
3	61	12	73

At the end of each period, therefore, an average of three larvae per bait was obtained.

Upon a third plot, with a moist soil beneath staging, twenty baits were set out in four rows, three feet apart, the five baits in each row being at a distance of eighteen inches from one another.

Table 2.

Period	Wireworms assembled		
	At baits	In soil	Total
1	54	22	76
2	62	23	85
3	98	26	124

During the first two periods, therefore, an average of four, and during the third of six wireworms per bait were trapped. Trapping over a period of twelve days did not effect a decrease in the number of larvae assembled at the baits at each successive period, indicating that the wireworms assemble at a slow rate. From other comparable plots, it was ascertained that appreciable numbers did not assemble at the baits until the third day after setting them in the ground.

Only a small proportion of larvae tunnelled into the carrots, so that the same baits could be employed over a period of at least fourteen days.

Note was taken of the number of larvae assembled at twenty-two baits which had remained in the ground for progressively lengthening periods of time :—

Table 3.

Baits previously in ground Days	Wireworms assembled		
	At baits	In soil	Total
Fresh	39	28	67
4	50	25	75
7	56	29	85
9	91	18	109
11 (19 baits)	68	10	78
16	68	20	88

The carrot slices therefore appeared to become rather more attractive when they had been in the ground for more than seven days.

The proportion of larvae which actually tunnelled into the baits was small, and it is possible that many assembled at the baits without actually feeding upon them. It seems also that a very prolonged period of trapping would be necessary in order to reduce materially the number of wireworms in a glasshouse soil.

Nearly all the larvae assembled at the baits measured $\frac{1}{2}$ inch or more in length, only two or three out of a total of over 1,100 were smaller.

With the object of shewing the length of time over which wireworms feed, single larvae were kept in small pots filled with soil and a fresh section of carrot was supplied to each daily over a period of five weeks. Marks made upon the cut surfaces of the carrot slice were taken to indicate that feeding had occurred.

Of twenty-seven wireworms previously trapped at carrot baits, but not supplied with food for about a week before the observations were begun on January 21st, the minimum period of feeding upon consecutive or almost consecutive days was six days (in one case only) and the maximum thirty-three days, with an average of nineteen days, after which feeding became very irregular and in some cases almost or entirely ceased during the remaining period.

The behaviour of two larvae which had received no food during the previous two months was different : with them feeding only started on the fourth or fifth day ; one fed on eleven consecutive days and on only one day during the remaining period of eighteen days ; the other on five consecutive days and irregularly on three days during the remaining period of twenty-five days.

Twenty-six larvae from the pots were introduced into pots containing lettuce plants at the termination of the observations ; in no case was a plant destroyed during a period of thirty-two days. Two larvae supplied with carrot fed irregularly during a period of six days, after which feeding ceased during the remaining period of five days.

It is not possible to draw definite conclusions from these observations, but there is some indication that, in the early months of the year, wireworms may be expected to feed more or less regularly over a period of some three weeks, after which feeding becomes irregular and may cease entirely for a prolonged period.

With a view to shewing the effects of a high wireworm population upon lettuce plants within a confined area, an experiment was carried out in a small glasshouse at Cheshunt, beginning on January 20th and extending into April. On one side of the house over an area 20 feet x 4 feet, seventy-six plants were set out on level ground in rows of four, and on the other, over an area of 15 feet x 4 feet, ninety-three plants mostly in rows of five upon ridges 4 inches high. Near the middle of each side, two rows of four plants each passed over a large lidless box sunk to a depth of six to eight inches, so that the edges were flush with the soil surface. Into the soil of one box, two hundred and fifty wireworms had been introduced, into the other two hundred, giving a population equivalent to about

three millions per acre over the surface area of each box. The wireworms, which had been obtained from carrot baits during the observations recorded above, were able to escape into the surrounding areas only at the soil surface.

Upon the third day after planting up, a row of wheat was drilled between the two rows of lettuce plants in each box: the wheat shewed above ground twelve days after sowing, and attained a height of five to six inches three weeks later. Temperatures were maintained between 52° F and 63° F, but on a few nights fell to about 40° F.

During the first nine days lettuce plants destroyed were replaced daily, but for six days following this period no replacements were made: after this, attacked plants were again replaced.

It will be seen from Table 4 that all plants put in during the first fourteen days were destroyed, but that, in order to maintain the full complement of plants, fewer replacements were necessary upon the level than upon the ridged soil.

Table 4.

Period	Level soil		Ridged soil	
	Total plantings	Plants Destroyed	Total plantings	Plants destroyed
Jan. 20-Feb. 4th	46	46	55	55
Feb. 4-Feb. 19th	13	5	25	17
Total	59	51	80	72

After February 19th, no further losses were sustained.

The great reduction in losses after February 4th is attributed to the germinated wheat which attracted the wireworms, and appeared to afford a marked degree of protection to the lettuce plants.

On March 6th the eight plants were removed from the box with level soil surface and replaced by eight young plants; these reached maturity in April in spite of the fact that some fifty wireworms were still present in the soil, representing a population of about seven hundred thousand per acre.

On February 25th the wheat row with three inches of soil beneath it was lifted from the box with ridged soil surface: it contained twenty wireworms, which had caused considerable injury to the roots. The eight lettuce plants were grown to maturity, and when cut the soil in the box contained fifty-five wireworms, representing a population of about five hundred thousand per acre.

The greater number of plants destroyed by wireworms which escaped from the boxes into the surrounding areas were situated in the northern and presumably warmer portion of the house. Upon the level side only nine plants were attacked, five being in the row adjoining the box on either side and four in rows up to four feet distant : only one plant succumbed upon the southern side.

Upon the ridged side a total of exactly one hundred plants were destroyed, sixty-one on the northern and thirty-nine on the southern side of the box. Plants in rows up to a distance of five feet were attacked already on the fourth day after the experiment was started, but only one plant was destroyed at this distance on the southern side at a much later date. Of the plants situated nearest to the outer wall of the house, thirty-seven were lost as against fourteen to seventeen in each of the long rows further distant from it.

In the two rows of five plants adjoining the box on each side, one plant put in at the start and a first replacement of another escaped attack ; on the other hand it was necessary to make four and six replacements respectively at two positions in rows four to five feet from the box.

The rows of plants extended to a distance of 5½ feet on the northern, but to 8 feet on the southern side of the box. In the five most distant rows of the latter area, only one plant was attacked at a late date. As it is considered probable that the wireworms did not reach the plants in these rows, twenty-five plants of the eighty-five originally set out upon the whole area are omitted from Table 5, which shews the number of plants and replacements open to attack at the beginning of each period and the number of them destroyed.

Table 5.

Period	No. of plants		Total plantings in each	Plants destroyed		Total
	Original	Replace-ments		Original	Replace-ments	
Jan. 20-29	60	63	123	24	39	63
* Jan 29-Feb 4	36	24	—	8	8	16
Feb. 4-19	28	32	37	6	15	21
Feb. 18-27	22	38	—	0	0	0
	Total	...	160	38	62	100

* No replacement of attacked plants was made during this period.

After the first ten days, during which a large proportion of plants were destroyed, there was a significant reduction in the num-

ber of plants attacked during the subsequent period of eighteen days, following which no losses were sustained and all the plants matured in April. The reduction and final cessation of attack appeared to be due to the wireworms having obtained the requisite amount of nourishment, after which they ceased to feed.

During the periods when immediate replacement of plants was effected, the large number of replacements, as compared with original plants destroyed, was due to the wireworms remaining at the site of the plants after their destruction : twenty-three plants of the first, sixteen of the second, ten of the third, eight of the fourth, four of the fifth and one of the sixth replacement were destroyed. Some observations were made upon individual plants during the period when no replacement of attacked plants was effected. The soil at or just below the roots of 14 plants destroyed contained fifteen wireworms : three—five days elapsed before these plants were replaced and only three of the fourteen replacements were attacked, indicating that the majority of wireworms had left the sites while they were unoccupied by plants.

Disturbance of the soil appeared also to induce the wire-worms to forsake sites of previously destroyed plants, and attack plants in the vicinity rather than replacements of the former. The soil was dug to a depth of six inches beneath the roots of thirteen attacked plants : it contained twenty wireworms which were returned to the sites, and thirteen fresh plants were immediately planted upon them. Two days later the plants were carefully lifted, and the soil at their roots contained only four wireworms. During a further period of five days none of these replacements was attacked, though seven were destroyed during the five days following this, and nine wireworms were recovered from their roots. During the period of seven days when no attack was made on these replacements, sixteen plants were destroyed in the vicinity of the sites which they occupied.

From the above record it is concluded that the wireworms moved more rapidly in looser than in more consolidated soil, and that they shewed a preference for warmer portions of the soil ; that germinating wheat afforded considerable protection to the lettuce plants even when the wireworm population of the soil was very high ; that replacements of lettuce plants previously destroyed to some extent protected established plants in their vicinity, though they were themselves repeatedly attacked.

4. Control of the Tomato Leaf Miner (*Phytomyxa soleni*, Macq.).

O. B. ORCHARD.

During the past few years, the tomato leaf miner has caused considerable damage to tomato crops on many nurseries in the Lea Valley. Although this pest has been established on a few

nurseries for many years damage to plants was seldom observed until the first four or five trusses of fruit had been gathered and with few exceptions, the injury was not sufficient to cause any apparent loss of crop. During the past three or four years, however, the pest has attacked plants on many nurseries during the propagating period, and at this stage the injury is so serious that unless growers concentrate on the destruction of the pest as soon as it appears it may become a major problem.

The insect overwinters in the soil as a crysalis, developing into a fly which seeks out the tomato seedlings and proceeds to deposit eggs in the leaf tissue. The most serious form of injury occurs when the emergence of the flies from the soil coincides with the propagation period when tomato seedlings are in the cotyledon and first leaf stages, for the flies deposit eggs in any available green growth and the development of the larvae weakens the plants immediately. When the attack develops so early in the life of the plant eggs are laid on young leaves as fast as they appear, and many cases have been observed where the larvae have penetrated the growing point and completely crippled the seedling plant.

Frequently no sign of injury is observed until shortly after the plants are planted in the houses, and in other cases, no miner appears on the foliage until about the end of April or the beginning of May.

The injury caused is less serious when the insect attacks the plant after planting out, but unless control measures are adopted the pest quickly mines so much foliage that some crops have been ruined by the end of July or August.

A great number of insecticides in the form of sprays and dusts have been employed in an attempt to control this pest. While the adult fly is easily destroyed by contact with many of these insecticides, it is practically impossible to destroy the larvae inside the leaf tissue. In practice it has not been found possible to obtain complete control by the use of insecticides alone, especially when the pest attacks plants in the seedling stages, for if used at concentrations strong enough to destroy the adult and the larvae at contact some injury to the plant invariably occurs.

When a severe attack develops in the seedling stages, nicotine at a dilution of one ounce in two gallons of water applied by means of an atomiser (obtainable from horticultural sundriesmen) is recommended. The spray should be applied above the plants and allowed to float about in the air making no attempt to wet the foliage as the object is to destroy the adult fly and not to destroy the larvae or eggs in the leaflets' By this method, very little spray is used and the operation requires only about five minutes in a house 100 feet x 15 feet. It is therefore possible to carry out the operation daily and so destroy the flies as they hatch out.

The application of nicotine by means of a hand atomiser has given much better control than by spraying in the ordinary way, probably because a greater concentration may be used without injuring the plants and because more frequent applications are possible.

The use of nicotine dusts has also given satisfactory results but under present conditions it is almost impossible to obtain suitable dusting apparatus.

To obtain complete control of the pest, in conjunction with the above use of insecticides, it is essential to remove all affected cotyledons. Even where large numbers of plants are involved it has been found that the removal of the cotyledons may be carried out rapidly by the use of scissors similar to those employed for thinning grapes. The cotyledons removed should be collected and burnt and by this means eggs and larvae are destroyed before the adult flies hatch out. A hat pin is useful for picking them up. Complete control of this pest has been obtained repeatedly by the above combined methods when the attack occurred during the propagation stage.

When the pest does not appear until several weeks after planting out, careful and complete removal of all leaflets shewing the typical " mining " is strongly advised. This ensures that large numbers of larvae are taken off the plants before they pupate and breeding of the pest is checked so much that later injury is much less serious than where the early removal of foliage is not practised. As an additional method of control spraying with nicotine at a dilution of 1 ounce in 4 gallons of water with the addition of a suitable wetting agent should be carried out at intervals of ten days.

As soon as spraying with oil emulsions for the control of the red spider mite commences, growers are advised to add nicotine in the above proportion to the diluted oil. This spraying, in conjunction with the systematic removal of all infested leaflets will prevent the pest from causing serious loss of crop.

Experience shews, however, that it is very important to concentrate on destroying the pest in the propagation stage should it become evident, as in all later stages control measures are much more difficult to apply.

4. Chemical Problems.

O. OWEN.

(a) General.

During the year some of the soil samples received for analysis have given nitrogen values which have been considerably higher than any recorded here during the last twenty years. These high values have occurred in soils which have not been used for growing, but have been under staging and have caught the leachings from pot plants stood thereon. In each of these cases organic matter has been correspondingly high, and as is well known under such conditions nitrogen tends to be fixed in the soil.

There have been more than the usual number of enquiries about soil nutrients from growers who had difficulty in setting fruit in the " middles " of the plants, i.e., on the fifth, sixth or seventh trusses. Only in a small minority have the analyses shewn abnormalities and these have been low in nitrogen in comparison with potash.

Generally speaking failure of these middle trusses is due to one or both of two causes namely a dry subsoil and a lack of available nitrogen. The former is corrected by adequate winter flooding and the use of straw walls as recommended by the Station. The latter is corrected by the use of a mixture containing 50 per cent dried blood. This should be applied before the 5th truss has appeared on most varieties except the Potentate type which requires it before the 4th truss appears. This need for nitrogen is liable to occur even on rich soils and in this connection it must again be pointed out that tomato plants are comparatively gross feeders. A satisfactory crop removes 600-700 lbs. potash (K_2O), 75 lbs. phosphoric acid (P_2O_5) and 350-400 lbs. nitrogen (N) while a really good crop such as is expected after steaming probably removes considerably more than these quantities.

A variety of materials have been examined for use as fertilisers. A number of proprietary fertilisers and mixtures suspected of causing damage to plants or of being below specification proved to be quite satisfactory. This has not been so with samples of flue dust. In these the potash content has varied from 0.30 per cent to 2.18 per cent K_2O and several have had injurious effects on tomato plants even in comparatively small amounts.

A grower had occasion to suspect what he considered to be an excess of fat in a sample of meat and bone meal. The actual content was found to be just under 9 per cent, and the material proved satisfactory in use.

Two samples of sewage sludge gave values of 1.4, 0.35, 0.57 and 2.59, 0.88, 0.17 respectively for N, P_2O_5 and K_2O. The second sample had no apparent effect on pot plants growing here in our ordinary compost.

One curious product deserves mention. It was offered as an animal manure and the grower concerned hoped it might prove a suitable substitute for stable manure. The analytical data were all on the low side, but the striking feature was that the sample as received contained only 12 per cent volatile matter of which about 2 per cent was moisture. The manurial constituents might well have been of animal origin, but to describe it as animal manure is somewhat misleading. The high inorganic content and low fertiliser value would have made it impossible to use under glass.

A sample of Milling Flock contained 11.7 per cent total nitrogen and we were informed that this material had given satisfaction.

In addition to the above the usual identifications of fertilisers in plain bags from which the labels had disappeared, were dealt with.

Six samples of soil suspected of being contaminated with chlorates were received. Using the improved method of Hunt (1) three of the samples were found to contain traces of chlorate.

Quite a number of ash samples were analysed for potash and they are dealt with later in a separate section of this report. In this connection it is important to know that on one nursery where the ash of sawdust from a mill is used fairly extensively workers found their hands were affected. There was a possibility that the ash contained appreciable amounts of caustic alkali. Examination shewed that this was not so, and it was concluded that during the damping preliminary to broadcasting the ash the workers' hands became wet and this together with the friction caused the irritation reported. When the ash was sown by spade and care taken to avoid undue contact with the hands the irritation disappeared.

(b) The Use of Molybdenum in Winter Lettuce.

Brenchley and Warington recently published an account (2) of the beneficial effect of molybdenum on lettuce. Experiments were carried out to determine whether this element could usefully be applied to Cheshunt Early Giant. The ordinary station propagating soil was treated with sodium molybdate to give concentrations of $\frac{1}{2}$, 1, $1\frac{1}{2}$ and 2 parts per million of molybdenum in the soil. Seedlings of Early Giant Lettuce were planted in the treated and untreated soils in 32 pots.

Twelve pots were used at each concentration and at the end of eight weeks there was no apparent difference in the plants. Concurrently a double row of the same variety of lettuce was treated with sodium molybdate solution to give a concentration of 1 part per million of molybdenum in the top four inches of soil. It was applied shortly after planting out. At the time of picking

there was no apparent effect on the plants as compared with the adjoining untreated plants. It is concluded that there is an adequate supply of molybdenum in our soil here.

(c) Plant Ashes as a source of Potash.

The restricted amounts of potash now available have compelled many growers to seek additional sources of supply and the oldest source of all, namely, ashes of various plants is now being widely exploited. During the past three years many samples have been analysed and as was expected the potash contents vary within wide limits, ranging from mere traces to 30 per cent K_2O. This high value was obtained from well manured tomato plants burnt carefully under controlled conditions and must be considered exceptional. Usually the figures range from about 2 to 6 per cent.

All the samples received in sufficient amount have been tried on plants and the results are now summarised. Tests were made in two ways. Ash was mixed up with virgin soil and young tomato plants showing 7 or 8 leaves were potted into the mixture in 32 pots. Another batch of plants in similar pots and the same untreated soil received the same amounts of the same ash as a top dressing. The main object of the tests was to determine how much the plants would tolerate and it was considered that a dressing corresponding to 1 lb. per square yard would be greater than any likely to be used. (Since this work was done a case has occurred where about twenty times this amount was used and none of the plants survived.) Accordingly the ash was mixed with, or applied to the soil at rates corresponding to 2, 8, 12 and 16 ounces per square yard. For comparison, plants were grown in untreated soil and in soil dressed with sulphate of potash at the rate of 2 and 4 ounces per square yard. Under the conditions of the experiments none of the plants showed any undesirable effects where the rates were 4, 8 and 12 ounces of ash per square yard. In no case was any undue hardness observed, and the leaves shewed a good green colour until the plants had grown to a stage where general symptoms of starvation made their appearance. In fact, until this stage they were definitely better in appearance than corresponding plants in untreated soil. At the same time plants treated with the sulphate of potash were shewing the usual signs of hardness associated with an excess of potash.

The plants receiving the maximum dressings of ash however, behaved rather differently. During dull weather they were apparently reacting in the same way as the other plants. But during a spell of brilliant sunshine which followed, definite leaf scorch was observed on leaflets at the base of the plants. This happened only with some samples of ash ; it did not even occur on all the plants treated with the same ash and where it did occur the ash

had been applied as top dressing. In no case was the scorch really severe and, in the main, the plants did not appear much the worse for it. In fact, at no stage up to the time the plants were 24 inches high were any but the lower leaflets affected and at no time did the tops shew any untoward effects.

In a later set of experiments when weather conditions were different the plants were exposed to continuous sunshine. Leaf scorch shewed again in the lowest leaflets but at a much earlier period but again there was no evidence of permanent injury to the plant as a whole.

It would thus appear that a dressing of about 1 lb. per square yard is in the region of the maximum top dressing of ash that tomato plants will tolerate. Confirmation of this was obtained when dressings in excess of this were applied. On very young plants in sunny weather scorch was sufficiently severe to do permanent injury and with one ash sample 2 lbs. per square yard caused complete collapse of some plants.

Probably the best way to use ash for tomatoes is in conjunction with the sulphate or muriate, and in fact this has been done on some nurseries. One grower considers better results are obtained in this way than by using sulphate of potash alone. In this connection it must be remembered that not only will plant ashes supply potash, but in addition some of the " minor " elements which are necessary for adequate plant nutritions.

(d) The reaction of Tomato Soils.

The application of lime to tomato soils in some form or other has been part of established practice for so many years that most soils nowadays contain appreciable amounts of calcium carbonate and the reaction of the soils is correspondingly high. Rarely does a cultivated soil shew a pH value below 7 and many of them are nearer 8. Under these conditions there is the possibility that tomatoes may suffer certain deficiencies particularly magnesium and manganese. Indeed some advisers are convinced that such high reaction values are definitely harmful and are recommending treatments to reduce the reaction. During the last twelve or fifteen years the Research Station has suggested continously that growers should reduce the dressings of lime considerably. This year one block of houses which had been steamed produced what appeared to be a very good crop and it is worth while tabulating the yields and the reaction of the soils in the different plots at the end of the season. They are shewn in the following table (1).

Table 1.

Plot No.	*Variety*	*Lbs. per plant*	*Tons per acre*	*Reaction* (pH)
71	Potentate	10.01	76.07	7.76
72	,,	9.47	71.98	7.82
73	,,	9.65	73.35	7.74
74	,,	8.87	67.42	7.72
81	,,	10.03	76.24	7.91
82	,,	10.58	80.40	7.69
83	,,	9.82	74.63	7.83
84	,,	9.95	75.62	7.78
91	E.S.1.	8.47	64.38	7.69
92	,,	8.62	65.51	7.93
93	,,	8.76	66.58	7.87
94	,,	8.45	64.22	7.91

The pH determinations were made on a Marconi-Ekco pH meter.

It should be pointed out that these houses have been in cultivation with tomatoes for 20 years and have had winter lettuce for a number of years. From a commercial point of view the crops must be considered very satisfactory. The figures are given to shew that even with such high pH values crops of this size can be produced if cultural conditions are favourable.

e) The Use of Muriate in place of Sulphate of Potash.

Pot experiments continued during the year have confirmed the view already expressed that more care is necessary in the use of the muriate than in that of the sulphate. Both fertilisers in equivalent amounts have been deliberately applied to large plants in such a way that the salts in each case have come into contact with large exposed roots and the stems. In no case was there any undesirable effect in the case of sulphate but where muriate was so applied a yellowing of the foliage was apparent within ten days. Where the amount of muriate used was of the order of 3 ounces per square yard the plant never recovered from the treatment and where the dressing exceeded this some of the plants shewed a tendency to collapse.

Arising out of these experiments is the indication that potash applied to pots has a more potent effect than a similar amount has when applied to borders.

Houses 7 and 8 have been used for muriate versus sulphate experiments for three consecutive years and the results are discussed elsewhere in this report. At various times during the year samples of soil from the plots have been analysed for chlorides.

This was not done systematically and the highest value during the season was 0.11 per cent calculated as sodium chloride for oven dried soil. This must have been a transient peak value as a sample from the same plot taken nine days later contained only 0.07 per cent. At the end of the season chloride determinations were made on all the soils. During September random samples of foliage were taken from each plot and also analysed for chlorides. The results are given in the following table 2.

Table 2.

Plot	*Treatment*	*Total chlorides in soil (% NaCl)*	*Chlorides in dry matter of foliage (% Cl)*
71	Sulphate	.0045	2.32
72	Muriate	.013	6.85
73	Sulphate	.0084	3.45
74	Muriate	.033	5.81
81	Muriate	.038	4.74
82	Sulphate	.015	2.08
83	Muriate	.062	5.82
84	Sulphate	.009	1.62

The figures for the soil are lower than was expected but it must be pointed out that these samples were taken on December 5th, 1942 a few days after the crop had been removed.

No muriate or sulphate had been applied after April and in the intervening time normal watering had been taking place regularly. Drainage is good and as the water used is not rich in chlorides constant leaching had been taking place.

With regard to the data for the foliage little can be said at this stage except that during the season only once did we notice any difference in the appearance of the plants receiving muriate as compared with those receiving sulphate. In June some of the muriate plants appeared to be paler in colour for a few days but the effect was not permanent and was not at all apparent to several independent observers a few days later. In other words under these conditions foliage may contain up to 6 per cent of chloride in the dry matter without either serious diminution in crop or effect on the appearance of the plants.

(f) Minor elements in Tomato Nutrition.

The importance of minor elements in plant nutrition is now well established. While deficiencies of these elements do not at the moment, constitute a serious problem to tomato growers as a whole,

an increasing number of disorders of tomato plants is being attributed to such deficiencies. Consequently preliminary experiments have been initiated to provide information concerning the role of some of these elements.

At this stage plants are being grown in sand and pure chemicals applied in solution in accordance with the formula of Templeman (3). To begin with plants have been grown with the complete nutrient and that nutrient without one or other of the elements or compounds. At this stage the results must be regarded as indicative rather than final. During the short period available it has not been possible to grow plants to maturity but enough has been done to shew that as was expected plants grow quite normally under these conditions and the same applies to several varieties of lettuce.

Three results have emerged to date.

The complete omission of manganese produces, in time, a characteristic mottle consisting at first of smallish pale patches against the dark green background of the leaf. The paler areas extend and later the centre of the leaflet loses the mottled effect which still remains nearer the margin. These effects are not uncommon on odd plants here and there on a nursery but although they have been observed for many years there is no evidence that they produce any serious effect on the cropping of the plants.

The omission of boron from the nutrient produces two effects. One is a very definite stunting. After six or seven weeks growth these plants are only a sixth of the height of plants receiving the complete nutrient. The other effect is in the foliage. To begin with the leaflets lose some of their green colour, paleness starting between the veins and extending outwards to the margins. Later some of the pale areas eventually become almost bleached. While this is happening marginal browning sets in irregularly and these two effects at certain stages are typical of some acute potash deficiency symptoms. Stalks of leaves are exceedingly brittle and break off even when handled carefully. Over a period of weeks, however, the growing tip never really dies and this is not in accordance with the experiences of other workers in this field.

Plants grown without magnesium sulphate shew more pronounced effects than any encountered. Growth is extremely limited and seedlings which had grown to $2\frac{1}{2}$ inches high had not attained a height of $3\frac{1}{2}$ inches eight weeks later. Apart from this the characteristic effect is tip burn of the leaflets, a pale colour and eventually desiccation, and the tendency of the leaves to curve downwards. This last characteristic is also typical of commercial plants known to be suffering from magnesium deficiency by tissue

analysis. Larger plants transferred rom complete nutrient to a magnesium sulphate free solution develop all their characteristics and also shew brown lesions on the leaf stems—not unlike those associated with the streak symptoms of Tomato Mosaic.

It must be emphasised that these results are merely those of preliminary work and some of them are in contradiction to results already obtained elsewhere. The work will be continued and more detailed results presented as they become available.

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Appendix B.

Manurial Treatment in Tomato Experiments,

(Except plots in Appendix C)

(1) **Lime.**

All houses received ground caustic lime at the rate of 1 ton per acre.

(2) **Houses 1, 2, 3, 4, 5, 6, 7, 8, 9, 10**

House 4, plots 1-3, 11 and 12; and house 10, plots 1 and 4, were all steamed, no base manures were added.

(3) **Top-dressing.**

Sulphate of Potash—All houses received a first top-dressing of sulphate of potash at the rate of 5 cwts. per acre.

Fertilizer mixture.—All houses except plots 1, 2, 3, and 10, 11, and 12, house 4, received 5 cwts. per acre of the following mixture every fourteen days at discretion :—

3 parts sulphate of ammonia,
2 parts dried blood.
7 parts 30% superphosphate.
5 parts pure dissolved bones.
½ part bone flour.
2½ parts sulphate of potash.

All houses received three top-dressings of the following mixture at the rate of 5 cwts. per acre :—

1 part sulphate of ammonia.
1 part nitrate of potash.
3 parts superphosphate.
5 parts dried blood.

except the muriate of potash plots in houses 7, 8, and 9, where muriate of potash was given instead of sulphate of potash.

Appendix C.

Manures applied to Plots 1-3, and 10-12 in Tomato House 4.

Plot.	TITLE.	Base Manure in Lbs. per sq. yd.				* Top-dressing in Lbs. per sq. yd.			
		Lime.	Stable Manure.	Basic Slag.	Sulphate of Potash.	Super-phosphate.	Sulph. of Ammonia.	Nitrate of Soda.	Sulph. of Potash.
1	Complete Artificials (I.) without Nitrogen	1.0	—	0.4	0.1	0.5	—	—	0.2
2	Unmanured	1.0	—	—	—	—	—	—	—
3	Complete Artificials	1.0	—	0.4	0.1	0.5	0.2	0.2	0.2
10	Complete Artificials with Dung	1 0	7	0.4	0.1	0.5	0.2	0.2	0.2
11	Complete Artificials without Phosphates	1.0	—	—	0.1	—	0.2	0.2	0.2
12	Complete Artificials without Potash	1.0	—	0.4	—	0.5	0.2	0.2	—

* The Top-dressing was applied in eight equal instalments.

Appendix D.

Dates of Cultural Operations, 1941—1942.

Crop.	Sown.	Potted into 60's.	Planted out in borders.	First Top Dressing.	First Fruit Picked.	Last Fruit Picked.
Tomatoes ...	Dec. 2 1941	Jan. 19 1942	Mar. 21 1942	April 18 1942	June 1 1942	Nov. 19 1942

Month.	Air Temperatures						Grass Temp.			Rainfall				Mean Soil Temperatures		Hygrometer				Bright Sunshine		Barometer
	Mean		Absolute Max.		Absolute Min.		Av. Min.	Absolute Min.		Total Precipitation	No. of Days P'p'tn.	Greatest Fall				Dry Bulb	Depres. of Wet Bulb	Relative Humidity %	Dew Point	Total No. of Hrs.	Daily Average.	
	Max.	Min.	Tem.	Date	Tem.	Date		Tem.	Date			Amt.	Date	1 ft.	2 ft.							
	°F.	°F.	°F.		°F.		°F.	°F.		Ins.		Ins.		°F.	°F.	°F.	°F		°F.			Ins.
January	38.4	27.0	51.0	4th	11.0	20th	25.0	6.0	20th	2.35	13	0.57	23rd	35.8	38.1	32.5	1.1	86.4	28.7	37.6	1.21	29.94
February	36.8	27 8	47.0	28th	19.0	8th	26.1	16.0	8th	0.47	6	0.21	3rd	33.8	35.3	32.2	1.0	88.3	29.1	27.9	1.00	30.02
March	48.8	34.6	63.0	25th	21.0	7th	30.0	18.0	7th	1.88	10	0.45	18th	38.6	38 9	40.0	1.4	88.3	36.6	71.8	2.32	29.85
April	58.7	40.6	68.0	18th	34.0	10th	37.0	28.0	15th	1.32	7	0.31	4th	46.3	45.7	48.4	2.0	86.0	44.1	222.0	7.40	29.96
May	63.7	43.6	75.0	6th 7th	34.0	3rd	40.6	28.0	2nd 3rd	2.56	15	0.76	10th	53.0	52.6	52.3	2.4	84.9	47.5	211.5	6.82	29.88
June	71.9	47.6	87.0	29th	37.0	10th 25th	45.3	33.0	25th	0.13	1	0.13	12th	59.0	58.3	59.5	4.6	73.4	50.7	238.0	7.93	30.10
July	71.5	52.2	80.0	5th	43 0	27th	49.7	40 0	27th	2.24	10	0.64	10th	62.8	62.5	61.2	1.2	92.6	59.0	175.0	5 65	29.94
August	73.1	54.0	90.0	28th	44.0	4th	49.8	38.0	4th	1.60	15	0.38	15th	62.7	62.0	63.5	1.7	89.6	60.2	148.0	4.77	29.93
September	67.3	48.8	79 0	11th	37.0	24th	44.2	32.0	24th	1.25	12	0.56	28th	57 3	58.8	57.5	1 0	93.9	55.7	106.2	3.54	29 88
October	59.6	43,8	69.0	3rd	33.0	26th	41.6	29.0	11th 26th	4.45	17	0.86	26th	51.4	52.9	51.0	0.4	97.1	50.1	73.2	2.36	29.91
November	47.8	34.4	55.0	10th	25.0	21st 22nd	31.5	21.0	22nd	2.15	9	1.06	5th	42.2	44.5	39.6	0.4	97.0	38.7	63.9	2.13	30.20
December	48 8	37.6	55.0	12th 13th 15th 16th 21st	25.0	2nd	34.1	16.0	3rd	2.51	16	0.59	5th	43.0	44.4	42.7	0.8	94.1	41.0	35.8	1.15	29.83

Total rain for year, 22.91 ins. No. of days precipitation, 131. Total bright sunshine for year, 1410.9 hours.

DIAGRAM SHEWING ARRANGEMENT OF EXPERIMENTAL PLOTS, 1942.